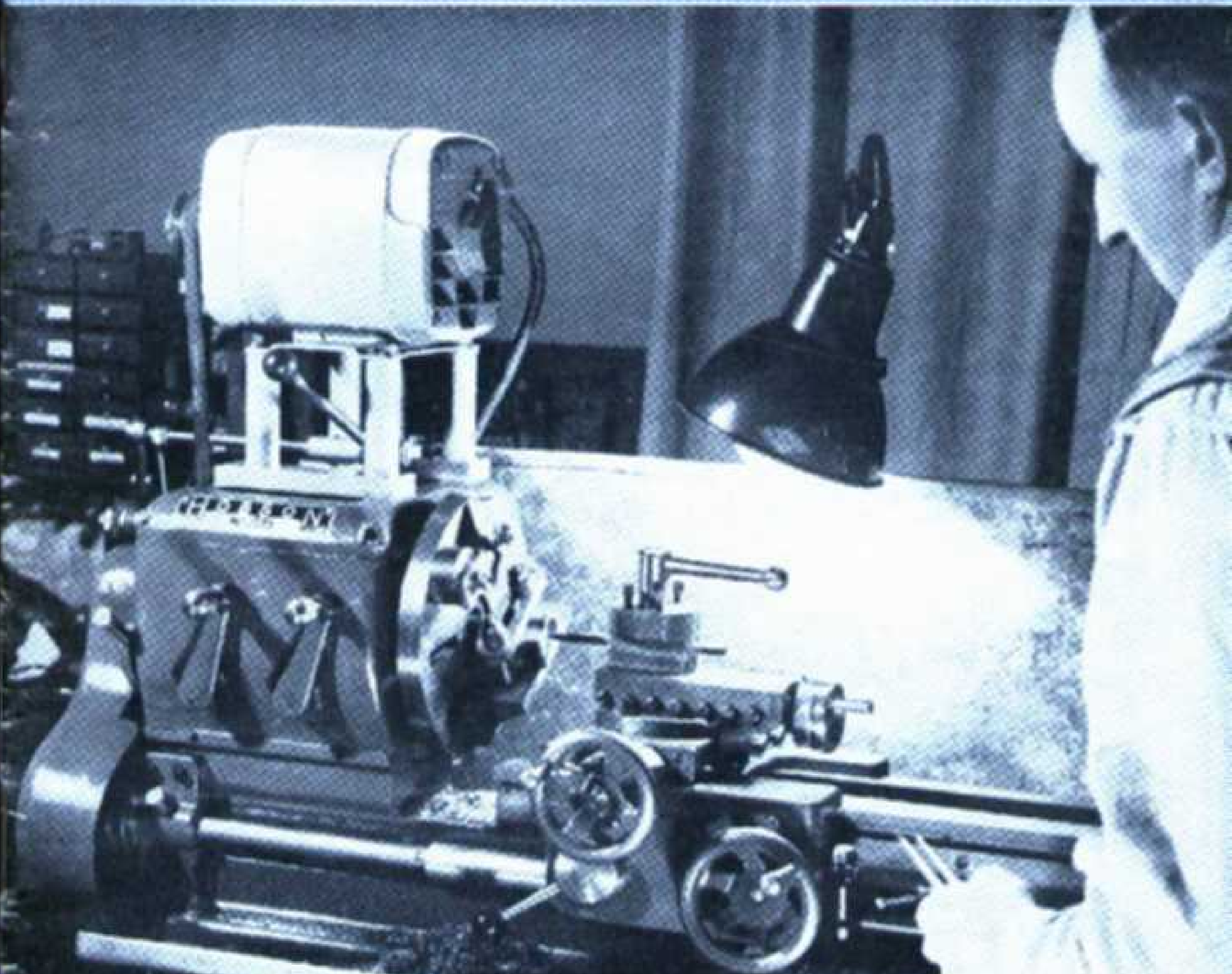
# THE MODEL ENGINEER



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TWIN SISTERS ● AIDS TO ACCURACY IN MARKING-OUT



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THE MODEL ENGINEER

EVERY THURSDAY

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### Our Cover Picture

This photograph, submitted to us by Mr. R. Key, of Stoke-on-Trent, was taken by himself, and depicts a typical machining operation on his 3½-in. Hobson lathe. Mr. Key is at present building a *Tich* 0-4-0 locomotive, and one of the cylinder castings, mounted on an angle-plate attached to the faceplate, is being bored by means of a single-point tool in the toolpost, the method of clamping the work and balancing the faceplate being clearly shown. The motor mounting on the top of the geared headstock casting is of interest, and was constructed in the workshop, together with a friction clutch, the operating lever of which can be seen below the motor. For the benefit of readers who may wish to photograph similar workshop subjects, the photograph was taken with the aid of a delayed-action shutter release, and the exposure was ½ sec. at F/11 using one photo-flood lamp, plus a 100-watt bulb in the lamp over the lathe. Clear and informative photographs of workshop operations, or other subjects relevant to model engineering are always welcomed for reproduction either on the "M.E." cover or in our editorial pages.

# SMOKE RINGS

### Is There Any Danger?

A READER expresses some trepidation with regard to traction engine races about which he has read in our pages; he writes: "The racing of traction engines, no doubt, provides a lot of fun, and considerable skill would be required to steer one of these old irons at the speeds they could attain; but hasn't anyone thought of the consequences of bursting the flywheel due to centrifugal force? Many people have been killed from this cause, in the early days of engineering."

To be frank, we have never thought of such a thing! We believe that the number of cases of burst flywheels, so far as Britain is concerned, can be counted as exceedingly few, and they occurred in the very early days, now about a century ago, since when the design and construction of flywheels has been greatly improved. We would be extremely interested to try a practical test with a view to noting the speed at which a flywheel burst. We have little doubt that it would far exceed that attained when the engine is running at her maximum road speed of about 15 m.p.h.

The only concern we feel, when watching a traction engine race, is for the engines themselves; we do really wonder how they manage to escape falling to pieces as a result of the terrific vibration and oscillation to which they are subjected. But they were beautifully built, and only those that are in good enough condition are allowed to race; so the chances of danger from any cause are very remote.

### Worcester M.E.S. Enterprise

THE FILM, "The Man Who Watched The Trains Go By," now being shown at cinemas all over the country, provided an opportunity for some enterprise on the part of the Worcester Model Engineering Society. When the film was on the programme of their local Gaumont cinema, recently, the members seized the opportunity to arrange with the manager, that a display of models should be set up in the foyer. The models included, among others: a 1½-in. scale road locomotive of the "showman's" variety, a 5-in. gauge passenger-hauling locomotive, a 3½-in. gauge "Rainhill," and another locomotive in course of construction.

We learn that this exhibition attracted a great deal of attention and that the society has benefited thereby. We feel that this is an example that might well be given some consideration by other societies; for, not only does such enterprise bring its own reward, but it helps to bring our hobby to the notice of the general public, perhaps even to a greater extent than does a specific model engineering exhibition. The latter tends to attract only those members of the public who are interested, to a greater or lesser extent, in model making; but to stage an exhibition where all sorts of people cannot fail to see it must have an even greater effect.

At Worcester, the inclusion of a partly-finished model was a happy thought; but we think the whole idea was excellent and deserved all praise.

### Calling Mexborough

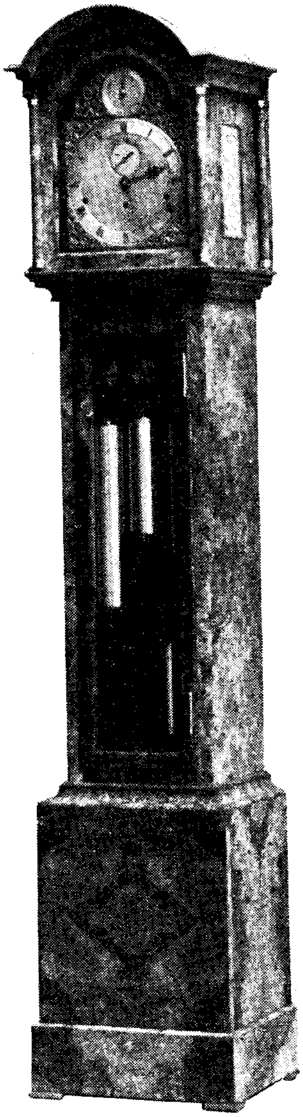
MR. FREDERICK LYTHGOE, hon. secretary of the Dearne District Society of Model and Experimental Engineers, has asked us to draw the attention of readers to the existence of his society. At present, there are twenty members, all active in some phase of model work. Eight locomotives are in various stages of construction, ranging from "O" gauge to 7¼-in. gauge.

A cordial invitation is extended to anybody interested to attend the next meeting which will be held on Thursday, April 16th, 7 p.m., at Hitchins Cafe, Market Street, Mexborough. Alternatively, Mr. Lythgoe would be glad to hear from anyone who may wish to join the society; his address is 2, Windhill Avenue, Mexborough.

# An original long-case clock

## with chiming, striking, and musical movements

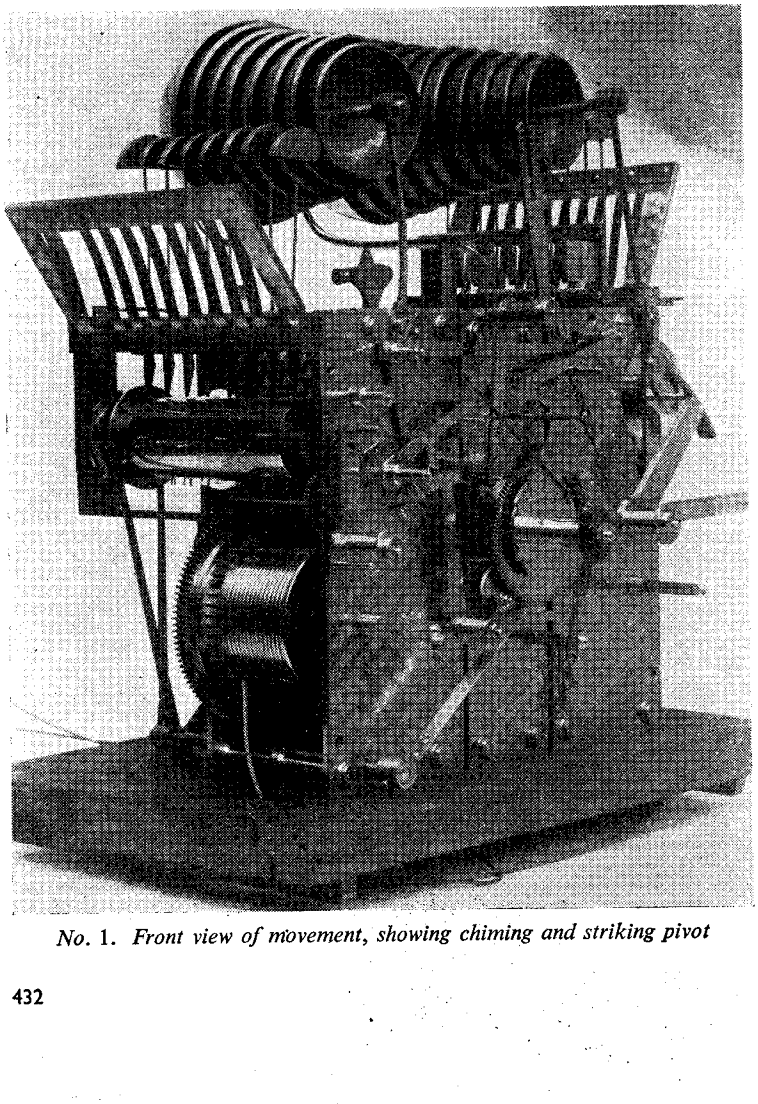
### By C. B. Reeve



A SHORT article on the construction of the chiming, striking and musical clock shown at the 1952 MODEL ENGINEER Exhibition would, it has been suggested, be of interest to horologically-minded readers. Quite a number of musical clocks have been made in the past by the old masters, but invariably they were striking movements with the addition of another train of wheels for the musical part positioned on the right-hand side of the movement. The writer, however, thought he would like to attempt to go the whole hog and construct a clock that would chime, strike and play a tune after the completion of each hour. As there was at this time a restriction of the sale of brass, it was decided to make do and use up all the oddments that happened to be around in the workshop.

A piece of brass plate, eight inches by seven inches was found for the back plate, but nothing suitable for the front plate, only some small odd pieces; the thought then occurred, why not make the front plate in three sections? It was a happy thought, as it has simplified the assembly of the movement enormously, which can be done completely in half an hour. It meant, of course, making more pillars, but this extra effort has been well repaid. It will be seen from the sketch (the only one made), there are in all twelve pillars, four to each section. These are screwed into the backplate up to a shoulder, but the frontplates are held to the pillars with twelve specially made steel screws and washers.

The next job undertaken was the three driving barrels; as they are identical to one another, they were all constructed together in their various stages of manufacture. The



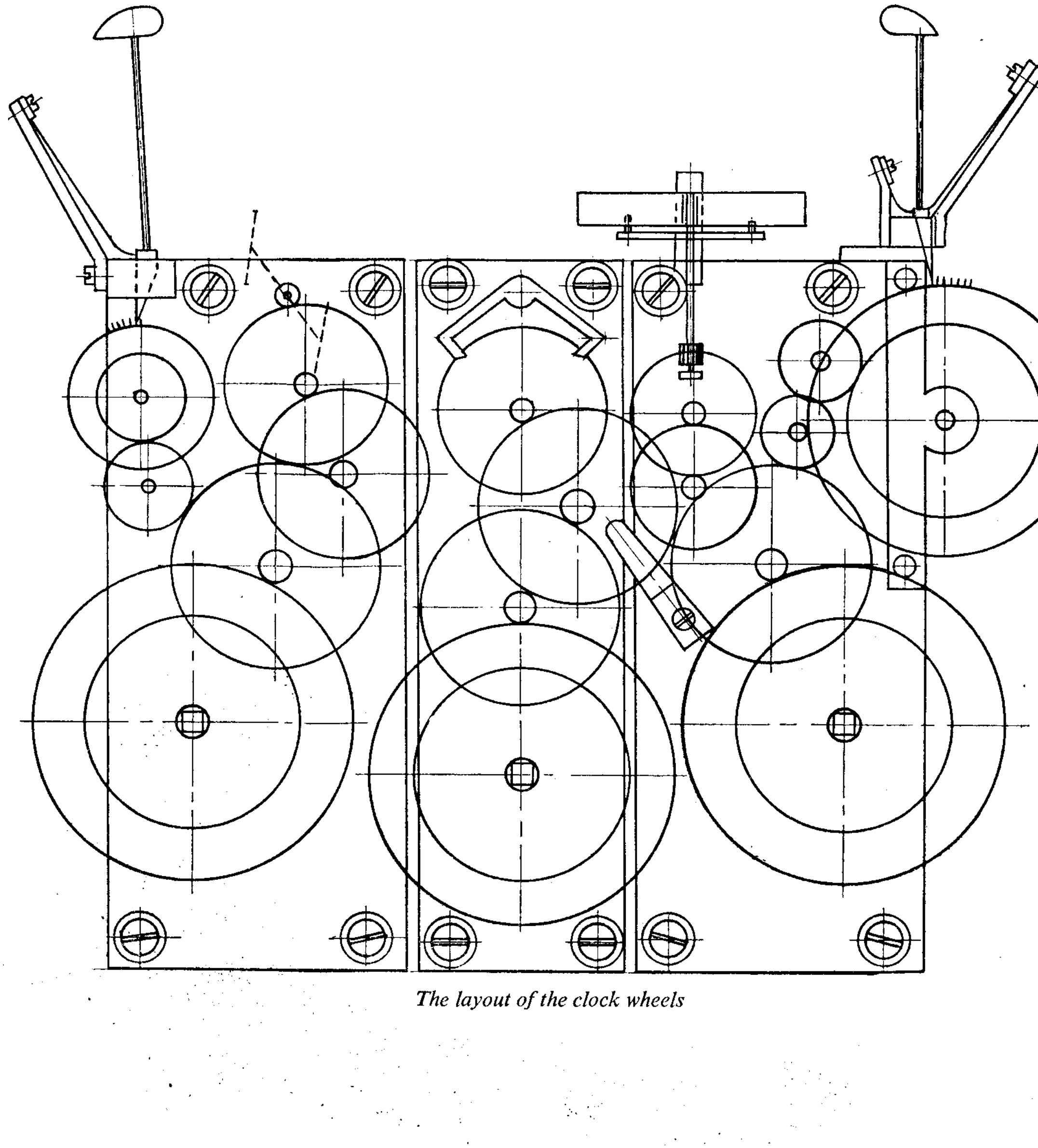
*No. 1. Front view of movement, showing chiming and striking pivot*

next operation was the cutting of the wheels. This was accomplished in the lathe, a division plate beng fitted to the tail-end of the mandrel and a simple cutter frame fitted to the slide-rest, the cutter frame being driven from a small electric motor, mounted in a vertical position, on a board hinged on the wall at the back of the lathe. This has proved a very simple and satisfactory arrangement, as the electric motor can be swung in and out from the wall, according to the diameter of the wheel that requires to have its teeth cut. This idea appeared in THE MODEL ENGINEER a few years ago, and has everything to recommend it.

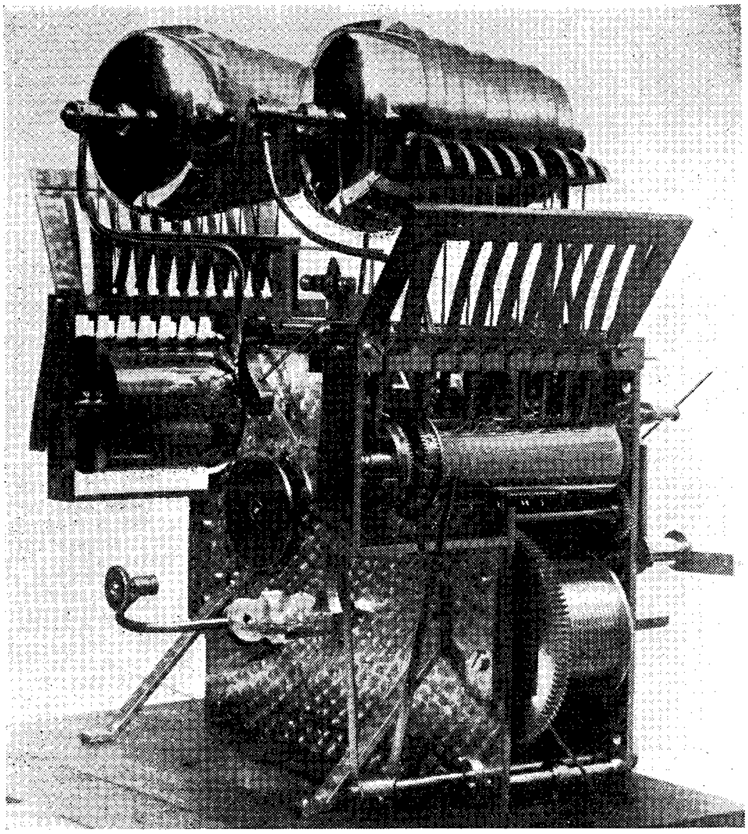
After all the wheels had been cut, a start was made on the centre or time train, which is a high-numbered one, pinions of twelve leaves being used throughout. This was a fairly straightforward task. After this came the escapement (a Graham dead-beat), and inside a month this part of the movement was operating with a temporary pendulum.

Now for the chiming and striking train, which is perhaps the most interesting part of the clock, and merits some description.

This part of the mechanism is situated on the left-hand side of the movement, and it will be seen that it has its own set of eight bells for the chimes, and one large bell for the hour. The latter has been removed from the backplate of the movement for photographic purposes, but its standard can be seen attached to the backplate. It appears that very few chiming and striking mechanisms have been made to work off one train of wheels, and the general opinion of professional clockmakers is that they are quite unreliable and impossible to adjust. However, this may be, the writer can only say he has now constructed three clocks with this arrangement; the first one made some twenty years ago, is still performing perfectly. The second one, a tubular chime and strike clock, with the chime barrel placed across the backplate, necessitating an extra contrate wheel in the train, was exhibited a the 1937 MODEL ENGINEER Exhibition, and



*The layout of the clock wheels*



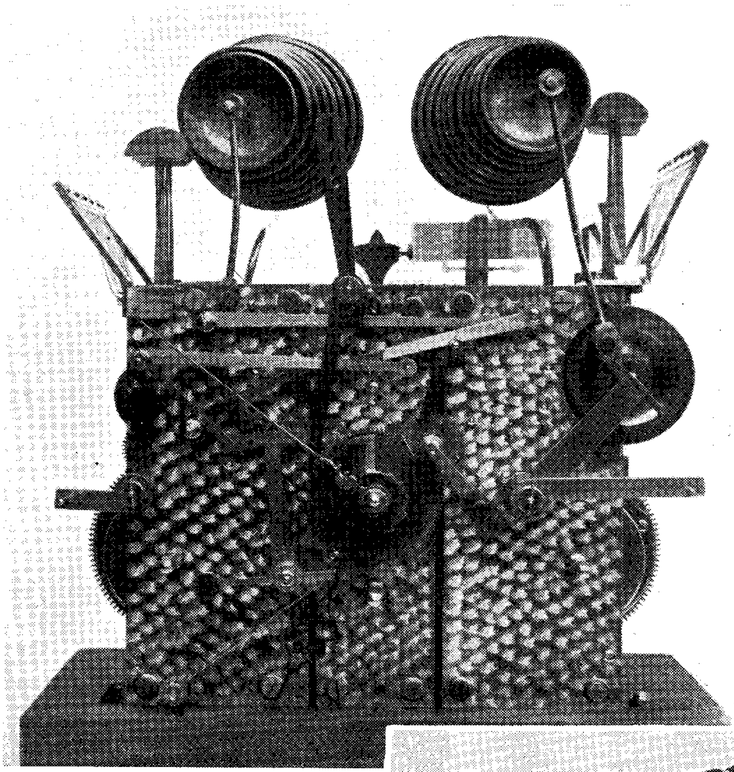
*No. 2. Back view of movement, showing chiming, striking and musical barrels*

except for an occasional oiling, has never been taken to pieces or cleaned since that date; and it is still " doing its stuff " with every satisfaction. The third clock, the subject of this article, has been going since last July without any attention or adjustment. Of course, the timing of this combined chiming and striking mechanism needs careful adjustment when putting it together, but so do also the chiming and striking trains of the modern movements. I think perhaps it is a question of understanding the object in view. Very briefly this is how it works.

The rack contains sixteen acting teeth, four for the quarters and twelve for the hours. This can be seen in photograph No. 1. The rack has two tails ; the longer one is used for the hours snail fitted on the hour wheel, and the shorter one is used for the quarter snail fitted on the lower minute wheel which can be seen in photograph No. 1. The upper minute wheel has four pins for raising the quarter lifting-piece (as in normal chiming movements), and therefore the rack hook every quarter of an hour. At the approach to the quarter past the hour, one of the four pins in the upper minute wheel will raise the lifting-piece, which in turn will lift the rack hook, thus allowing the rack to fall one tooth, due to the fact that the smaller tail of the rack has fallen against the highest step on the quarter snail situated on the lower minute wheel. It should be said that, attached to the lifting-piece, there is a warning-piece projecting from the upper arm of the lifting-piece, going through a hole in the frontplate ; during the time between warning and chiming, this stands in the way of a pin in the warning wheel (this wheel is the one next below the fly). Except for a few minutes before chiming takes place, the combined chiming and striking train is prevented running by the tail end of the gathering pallet, resting on a pin on the end of the rack. This can be seen in photograph No. 1.

Exactly at the quarter, the pin in the minute wheel has moved past the lifting-piece, which then drops back to its normal resting position and the train at once runs and the first quarter, and a peal of eight bells, is chimed. At the half-hour the same thing takes place, except that the shorter tail of the rack contacts the next deeper step on the quarter snail. The rack then falls two teeth and two peals of eight bells each are chimed ; at the third quarter, the rack falls three teeth and three peals of eight bells each are chimed. It should be stated that whilst the three quarters have been chimed, the long tail of the rack has not reached any of the steps on the hour snail (attached to the hour wheel). At the hour, the same action takes place, but it will be seen that the fourth step on the quarter snail has been cut away and, therefore, the shorter rack tail does not contact the quarter snail when the rack falls, but instead, the longer rack tail falls on the appropriate step on the hour snail. Taking as an example, say, three o'clock, the rack falls a total of seven teeth, four for chiming and three tor striking. A glance at photograph No. 2, left-hand side of movement, it will be seen that there is a flange at the end of the chime barrel ; also, there is a two-armed lever fixed to an arbor pivoted between the clock plates near the bottom. On the front end of the arbor there is fixed a weak spring.

Now, a few minutes before the hour is chimed and struck, a pin on the lower minute wheel will contact this spring, inducing the outer arm of the lever to contact the flange on the chime barrel, and immediately chiming is completed, a pin on the end of this outer arm will fall into a notch in the flange and thus arrest the chiming barrel. At the same time as this happens, the other arm of the lever will come out of one of the five notches formed in the flange attached to the striking barrel, and the clock will at once strike three o'clock. At a few minutes past the hour, the pin in the lower minute wheel will have moved away from the spring fixed on the arbor, with the result that the two-armed lever will fall back to its original position, bringing the pin out of the flange attached to the chime barrel, and the other arm of the lever will fall again into one of the notches of the flange attached to the striking barrel, and thus lock it again. Both chiming and striking barrels revolve independently on the chiming arbor, but each has a contrate wheel attached to its respective flange. Between the contrate wheels there is fixed to the chiming arbor a kind of lathe carrier, in the tail of which there is a window containing a steel



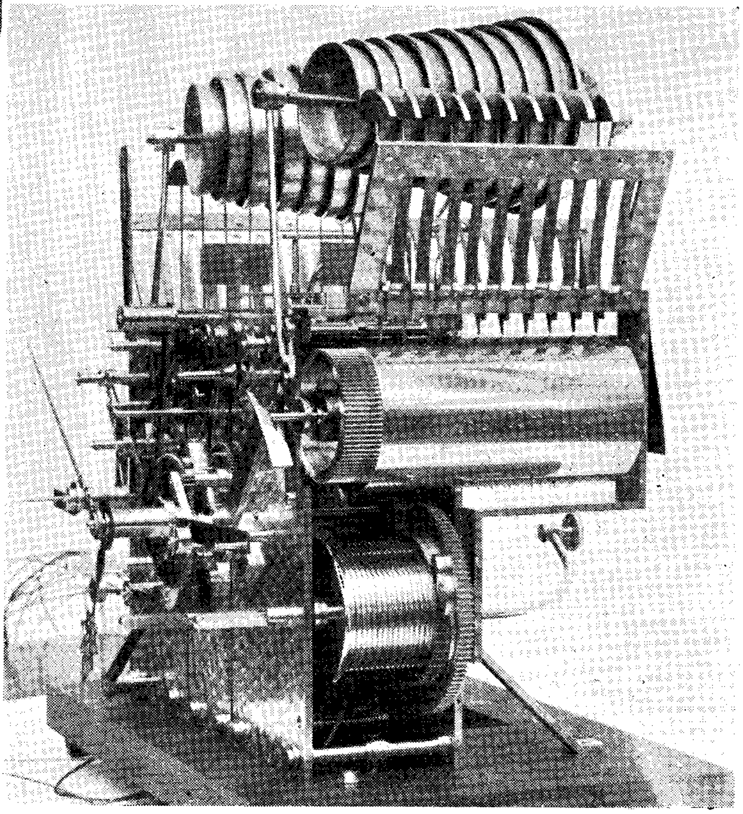
*No. 3. Front view of movement, showing position of various levers*

pinion which meshes with the teeth of both contrate wheels, acting as a differential when the chiming and striking action takes place. There are alternative chimes of Whittington and St. Michael ; the lever for altering the chimes can be seen on the left-hand side of the frontplate, a pin on the lever arranged to come through a slot in the dial plate. The pallet wheel of the combined chiming and striking train makes half a rotation per peal or stroke on the hour bell. This is necessary to conserve the length of the fall of the weight.

The making of the musical train proved a fairly straightforward task. It is worked on the " locking plate " or count wheel principle, one rotation of the locking plate equalling one rotation of the musical barrel. The locking plate can be clearly seen in photograph No. 2, the locking lever resting in the notch of the locking plate. The letting off of the musical train is worked by an arrangement of levers, through a pin on the chiming and striking rack, so arranged that after the completion of the striking of the hour, there is a moment's pause before the tune commences. There is a choice of four tunes which are " Easter Hymn," " Harvest Hymn," " All Through the Night " and " Blue Bells of Scotland." The choice of the tunes was somewhat limited with a set of ten bells in the key of C Major.

The writer has often been asked how the chimes and tunes are set out on the barrels ; actually, there are several ways of doing this. In this instance, charts were made on thin paper and stuck to the barrels, and the positions of the pins were centre-popped on to the barrels with a very small centre-punch. After this operation, the barrels were drilled, and in the case of the musical barrel, the holes were very small in diameter, being about 78 size gauge drill ; the barrels are very thin-walled and required very careful turning on the lathe to bring them to run quite true on their respective arbors. It will be noticed that the musical train has a vertical fly. This works very quietly and spins extremely easily. A mere

(*Continued on page* 440)



*Right—No. 4. View showing musical side of movement*

# THE FIFTH NORTHERN MODELS EXHIBITION

## REPORTED BY "NORTHERNER"

ONCE more it has been my pleasure to attend an exhibition organised by the Northern Association of Model Engineers, and again it is my privilege to report it for the benefit of readers who were not so fortunate. Naturally, a preliminary report such as this can only touch on a few highlights of the show—it is being written at the end of the first day—but enough has been seen in this one day to form the opinion that in many ways the exhibition is better than before.

The impression, for example, is that the general standard of craftsmanship is higher than in previous exhibitions, except, I regret to say, in the marine section, of which more will be said shortly. Another improvement is that more space is available, owing to the fact that the large central arena of previous years used for flying and racing cars, has been cut down considerably, because the Grand Prix racing track does not require nearly so much space. And so one could go on, but one won't !

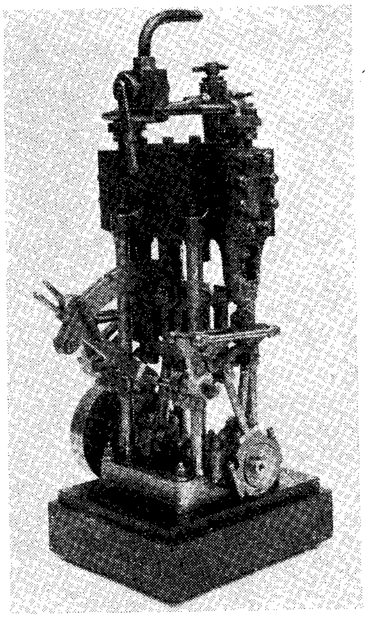
One of the major attractions at this year's show was again Mr. H. Slack's model three-abreast galloping horses, which won the premier awards here in 1952 and which I subsequently described in THE MODEL ENGINEER. Since then, this masterpiece has worked a great number of hours at other exhibitions in the North, but it runs as well as ever, and is as fascinating as ever. Watch out for it at the "M.E." London exhibition in August if you haven't already seen it (or for that matter if you have !).

**Locomotive Prize Winner**

In the locomotive section the model which won the *Evening Chronicle* Cup and the first prize was a $3\frac{1}{2}$-in. gauge Eastern Region Pacific built by F. L. Smith, of Bamber Bridge. This had an excellent finish, both in bright parts and in the paintwork, with good lining and lettering. It had three cylinders : the valve gear was neatly made with fluted rods, and screw reversing gear was fitted.

Details included working brake gear on both engine and tender and the backhead was tidily arranged. As on several other of the locomotives there were neat rows of rivets on footboards, cab and tender which added a good deal to the realism.

Runners-up to Mr. Smith were a $3\frac{1}{2}$-in. gauge "Princess Royal" and ditto "Rainhill" in that order, but of these I shall have more to say in a subsequent issue.

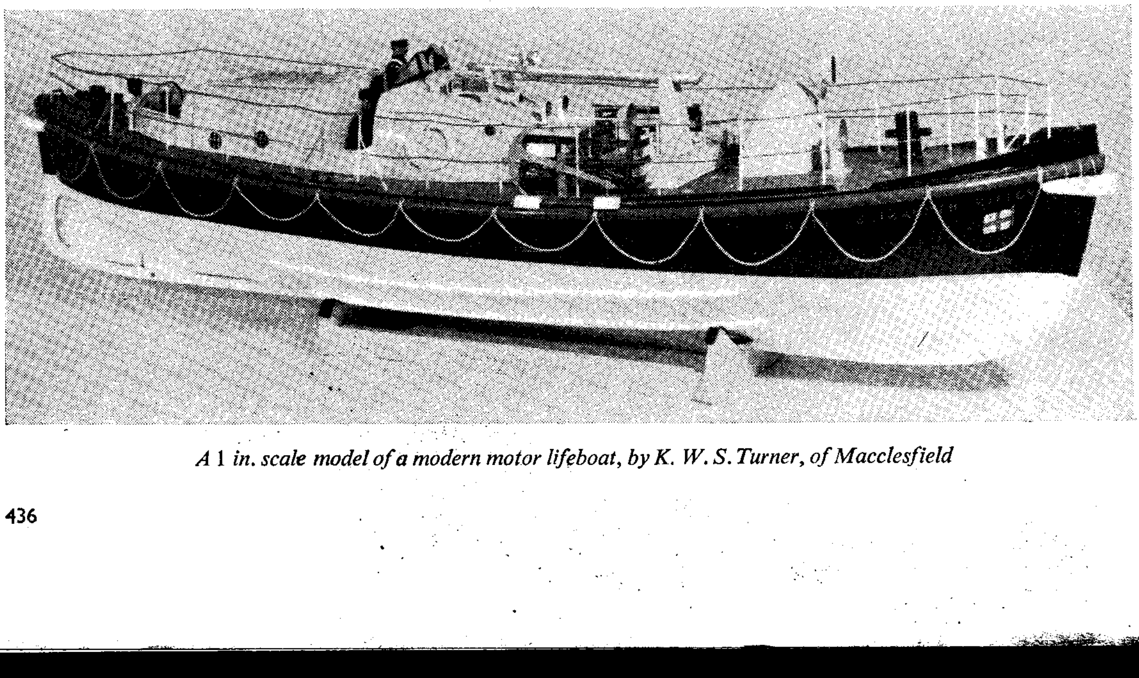


*A twin-cylinder launch engine, loaned by H. Mitchell, of Manchester*

**Marine Models**

It has been said that an Englishman has the sea in his blood, and this seems to be borne out usually at exhibitions by the number of marine models. Manchester was no exception, for there appeared to be more exhibits in this section than in any other.

There were, of course, the usual sub-divisions of power boats, non-working and scenic models, and so forth, but it has to be said—and I know the judges of the section



*A 1 in. scale model of a modern motor lifeboat, by K. W. S. Turner, of Macclesfield*

would agree—that even the prize-winners could have been appreciably better.

Of these, the winner of the Marine Trophy, and first prize in the power boats, was a free-lance luxury liner by W. E. Barnes, of Wilmslow. This impressive model was full of detail, and the builder had obviously taken pains with its construction. The hull and upperworks were of what might be termed composite construction, in wood and sheet metal, the former having apparently a wooden stem-piece and bottom with sheet metal sides, and the latter having metal sides or walls and wooden decks. The model was about 7 ft. long.

Paintwork was perhaps rather above average—certainly better than the other marine models—but through it there were visible large numbers of countersunk headed wood screws which held various parts together. These might have been very much smaller ; the heads could then have been countersunk below the surface of the metal, and the holes filled up and smoothed off flush.

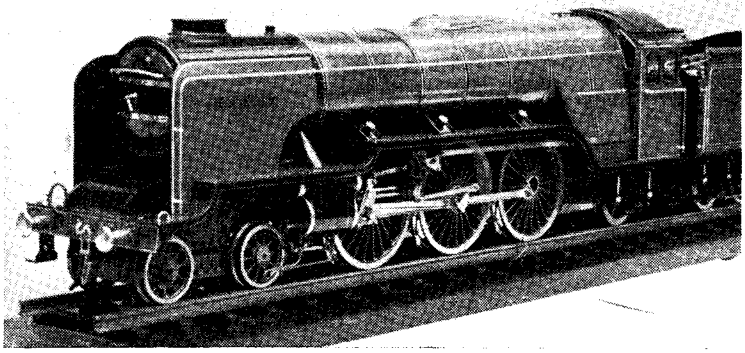
**Brass Fittings !**

Another major point of criticism was the brass deck fittings such as windlasses and winches. These possessed little of the real detail that *could* have been fitted, and were left naked and unashamed as brass fittings instead of being painted, as they should have been. Companion-ladders were bent up from thin copper sheet, left naked, and the derrick arms were swung on two ordinary brass screw-eyes, instead of on correct fittings.

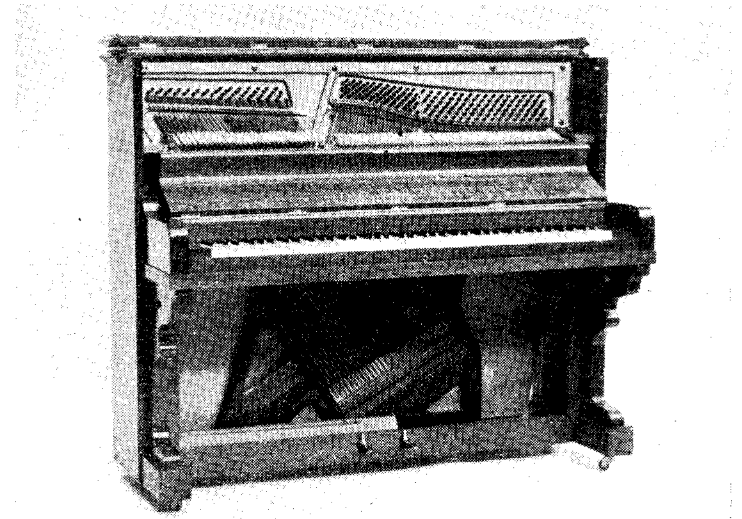
On deck aft a large brass plate carried an undisguised switch and rudder control, both entirely out of keeping, and both capable of either disguise or concealment. Deck planking throughout was marked by grooves, which, if increase to full-size, would be about 3 in. across and even deeper, resulting in as fine a crop of broken ankles and subsequent claims for damages, as any shipping company's financial resources could cope with.

I don't wish to imply that this was a bad model, because if it had been, obviously it would not have achieved its position in the prize list. But like many another model in the show (or in any show, for that matter) it could have been *better* without a lot of extra trouble, and the points mentioned above are instances of this.

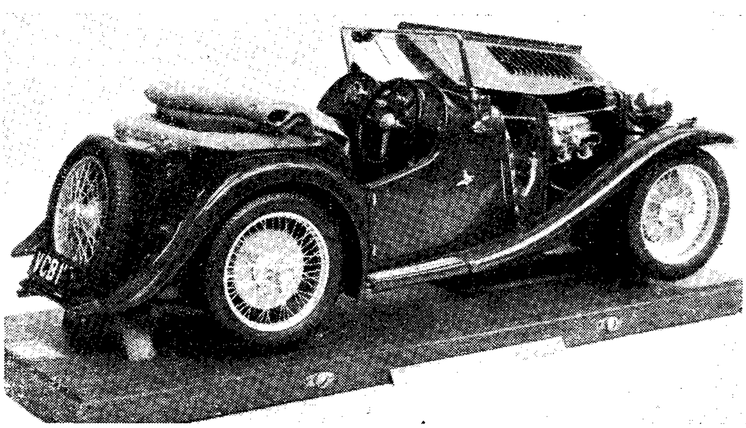
Second prize winner in the class was a $\frac{1}{2}$-in. scale motor yacht *Sea*



*The $3\frac{1}{2}$-in. gauge Eastern Region Pacific locomotive, by F. L. Smith, of Bamber Bridge, which won the "Evening Chronicle" Cup*



*Complete in every working detail, the 1/3 scale overstrung piano, by H. A. J. Smith, of Bexley Heath, earned top awards in the General Models class*



*Mr. F. H. Buckley, of Ashford, Middlesex, took first place in the Road Vehicles class with his 1/6 scale M.G. car*

*Huntress*, built by A. Riley, of Blackpool. This model was very fully detailed, internally as well as externally; on the foredeck, for instance, was a *working* (electric-powered) model Hyland windlass which was the nicest small deck accessory I have seen for a long time. However, this boat will be more fully described later, along with others in the section, including an 8 ft. long *Mauretania* and a 1-in. scale lifeboat.

**Familiar Models**

A few of the models at Manchester had been seen previously at last year's London exhibition, among them (on loan) Mr. Tucker's Championship Cup winner, the triple expansion launch engine. Since this has already been faithfully dealt with in these pages by its builder, I will say no more about it here except to mention that it was very pleasing to have another opportunity of examining it, and admiring once more the beautiful craftsmanship.

Then there was the magnificent overstrung piano, built to one-third scale by H. A. J. Smith, of Bexley Heath. This is another well-nigh perfect model—if there is a blemish anywhere on it I failed to find it—and it deservedly won the Myford Trophy for the best model in the exhibition, and the N.A.M.E. Trophy in the general models class.

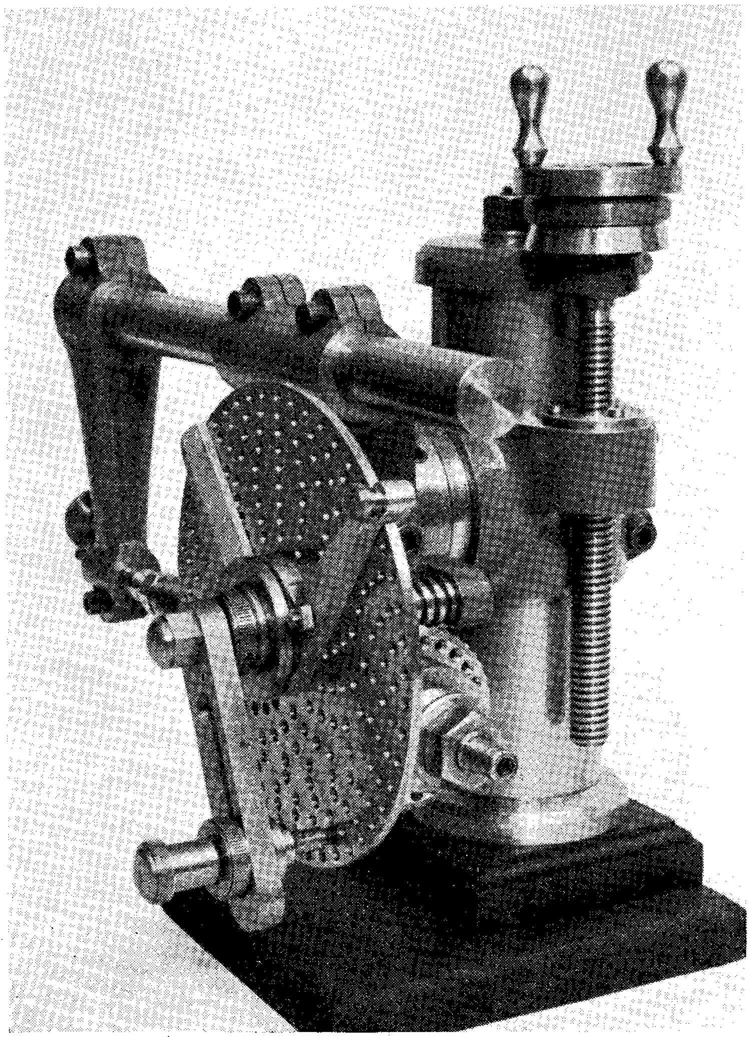
The piano has a full keyboard, and, of course, all the operating mechanism of the prototype—fifty full sets of it, as well as the pedal actions. But not content with this, Mr. Smith had gilded the lily by including, mounted on a separate board, a demonstration action, from key to hammer, to show just how the thing worked. Methinks that for me that one would have been the last straw! The piano case had been built in mahogany, french-polished, and it is understood that some 1,700 hours were spent in the whole piano from start to finish. A beautiful job indeed!

Winner of the Road Vehicle class, and close runner-up for the Myford Trophy, was a one-sixth scale model of an M.G. car of the P-type of 1935, by F. H. Buckley, of Ashford, in Middlesex. Again this model is well-nigh perfect, and one imagines that Mr. Buckley had a prototype handy to copy. One bystander assured me that no radiator fan should have been fitted, and if this is really the case, it seems odd that such an elementary error should be made when everything else was so accurate. Perhaps Mr. Buckley would let us know the whys and wherefores of the case himself.

The engine of the model is to scale, and contains a six-volt electric motor whose variable speed is controlled from the accelerator pedal in the cockpit. Twin "S.U. carburettors" are fitted. Drive to the propeller shaft is through a clutch and gearbox, with three speeds and reverse: full differential is fitted in the rear axle.

All the hubs are equipped with internal expanding brakes, operated from the foot-pedal and hand lever, and the foot-brake operates the stop-light at the rear. Electrical equipment is complete throughout—even the lights in the instrument panel work!—and all controlled by the correct types of switch on the dashboard. Even the trafficators and the miniature electric horn work!

In the finish of the model, Mr. Buckley has set a standard that has to be seen to be believed. The coachwork is really superb, the body being all metal on a metal frame; doors are correctly hinged and the door-catches are perfect replicas of the originals. Painting is smooth and glossy and is everything it should be. Correctly hinged hood-frame and hood, perfect upholstery, perfect dials (apparently photographically reproduced) to the instruments, even a perfect road fund licence on the windscreen: nothing to criticise there.



*An excellent example of the Turpin universal dividing head by E. Younghusband, of Swinton*

**Good Enough ?**

In fact, in all the three last-mentioned models—the triple-expansion, the piano, and the M.G., all of such widely varying prototypes—there was food for thought for the fellow who says "Aw, that'll be good enough," or "It'll have to do." For such models as these should serve as an inspiration, and perhaps a promise, to all of us. They demonstrate that *extra* care, and *extra* attention to detail and finish, can pay dividends not only in competition work (which doesn't attract everybody anyway !) but in self-satisfaction and contentment (which surely does!).

**Petrol Engines**

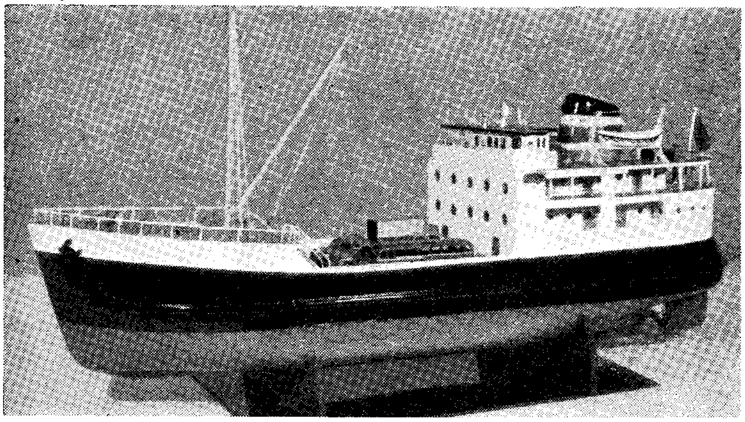
In the i.c. engine competition section, there were only three exhibits, but quite a number were on loan. Of the former, the first prize winner was a free-lance engine by A. Shaw, of Manchester. The finish was not very good, it is true, but it scored heavily on the fact that a great deal of thought and work had gone into it. There were four cylinders, and the overhead valves were driven through rockers operated by an overhead camshaft. This was gear-driven from the crankshaft, as was the home-built magneto. All gears were enclosed, but one felt that this refinement might have been applied also to the camshaft, preferably from the designing stage.

In the loan section, an extremely interesting engine was that fitted to a 55-in. hull by F. W. Waterton, of Stretford. Of the hull I shall treat more fully subsequently, but the engine may be mentioned here. It is a very neat design, with six cylinders and twin overhead camshafts, in this case totally enclosed. Water-cooling is employed, the pump being driven from one of the camshafts.

The flywheel is "built-in" the extended crankcase, and a gearbox is incorporated very neatly to drive the two propeller shafts, the two gear levers protruding through the top of its casing. So far as one could judge from the exterior, workmanship was good, and this is another of those models which one anticipates with pleasure seeing in its completed state at some future exhibition.

**Steam Engines**

Again in the competition section which included steam engines, there were not many entries, and I was sorry that the two models entered by F. D. Woodall, of Shipley, were not present. They were a Cornish Pumping Engine and a mines ventilating fan engine of 1864, and having seen his work on previous occasions, I was looking forward to these too; also to meeting the builder himself again. But this must be a pleasure deferred, apparently.



*A model passenger and motor-car ferry, entered in the Junior Section by W. Barnes, of Wilmslow*

A model beam-engine to the well-known MODEL ENGINEER design was awarded first prize, and was certainly worthy of it. Most readers will be familiar with the design itself, as it has featured fairly often in THE MODEL ENGINEER within the past year or two, and so far as one can remember this model follows the published design closely.

It was built by G. Brook of Brighouse ; he had paid due attention to detail, and in general the finish was very good. The paint, however, was a somewhat bright green, which jarred a little, and in places—for example, on the soleplate of the engine—it had been applied on surfaces which were not sufficiently prepared beforehand. Cast surfaces which have not been machined should have a certain amount of "fettling," and if necessary a filler should be applied before painting.

As is always the case at exhibitions, models actually at work attract the visitors more than the static ones, and a good number of steam engines were to be seen at Manchester working under compressed air. A steady "thud, thud, thud" continuously drew attention to the Massey steam hammer built by the popular and irrepressible F. J. Haynes, which I described (the hammer, not Fred) and illustrated last year. (You should have heard his description of me to a mutual friend earlier on : but perhaps on second thoughts you shouldn't !)

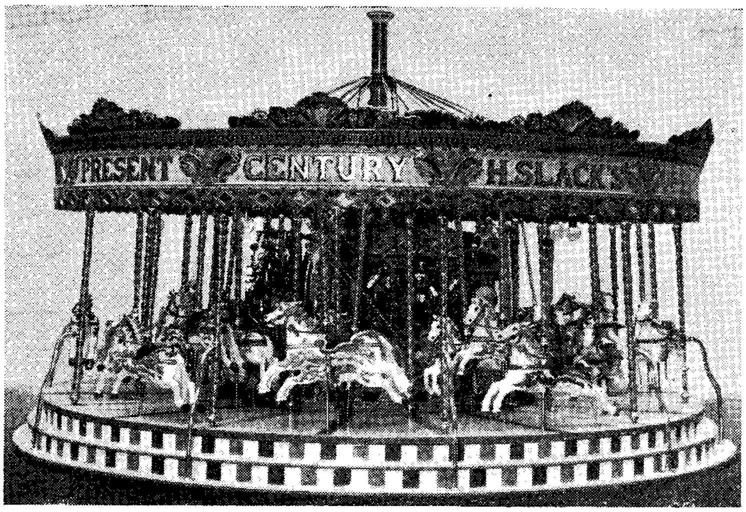
There were also four model steam engines built by the late D. E. Haywood, who did not start model engineering until after his retirement at the age of sixty years, but who nevertheless managed to build a dozen or more historical types of engine before his death at the age of eighty-six years. Here again I hope to describe and illustrate later some of his work in more detail than is possible in this review.

**Workshop Equipment**

There is undoubtedly a great satisfaction to be had in making equipment for one's own workshop ; some of this is due, of course, to the happiness derived from making anything at all, some perhaps to the fact that hard-earned money is being saved by so doing, and some because one's own creation naturally *seems* better than the purchased article. (Even when it really isn't !) And no one appreciates this more than your canny Northerner.

In both loan and competition sections, therefore, there was a fair amount of workshop equipment, and the standard of work was generally very high. The Harper Trophy, which was the premier award in this group, was won by E. Younghusband, of Swinton, for his equipment for milling and dividing in the lathe, of which there were several pieces.

His dividing head was of the worm-gear type, mounted on a short column ; the feed-screw collar was indexed, and so was the base of the column. Another of his exhibits was a very useful rotary milling-table, and further accessories included a neat collet set, a machine-vice, a tee-slotted angle-block, and a face-plate. All of this equipment was beautifully finished, but not *too* highly.




*The complete steam-driven working model roundabout, by Mr. H. Slack, was again one of the main attractions of the exhibition*

**Junior Work**

It may be trite, but it is nevertheless true, to say that the juniors of today are the model engineers of tomorrow, and that, therefore, they should be encouraged as much as possible, both by precept and by recognition of their work.

The late Reginald Lawton, who was so largely responsible for the success of the past four N.A.M.E. exhibitions, and whose activities in the radio-control field were so widely known, was also keenly interested in youth. Thus the N.A.M.E. have thought it fitting to introduce the Lawton Trophy in his memory, to be awarded in the junior section of the exhibition. It has been won for the first time by D. Greaves, of Middleton, who is aged sixteen, his model being a $\frac{1}{16}$-in. scale model of the four-masted barque *Archibald Russell*. This is a long job for a youth to tackle, and it is a tribute to his patience and perseverance that the finished model does not bear signs of being rushed to complete it.

It is, in fact, an excellent little model. One would not expect perfection from a lad of this age, and, of course, he has not achieved it, but it can be said without exaggeration that one has seen much worse work by some of his elders ! The paintwork was very reasonable, the cordage was taut and neat, and the deck fittings were good. This young man has made a good start, and should do well in future. Perhaps an older hand may be permitted to offer a few words of advice, however : first, don't let success go to your head ; second, be prepared to accept criticism and advice ; and third, don't open your mouth, or close your ears, too much !

**Special Displays**

We have already mentioned some of what might be termed the "special attractions," but there were others besides.

As is well known, the International Radio-Controlled Models Society was originally formed in the North, though its influence is now worldwide. Its part in this exhibition included a display of radio-controlled models of many types, some of which were demonstrated from time to time. But (dare it be mentioned ?) one has the impression that many of the radio wallahs regard the model merely as a convenient means of displaying their prowess with radio, though there are exceptions, of course. But I do submit that a decent radio set is worthy of a decent cabinet !

Brief mention has been made of the Grand Prix race car track. This was constructed, and operated, by the Southport Model and Engineering Club ; it is of figure-eight shape, which gives the same "lap-mileage" to all the three cars in the three lanes, though not so realistic as other layouts. Without a doubt this feature was very popular with the crowds, and so was the model tramway exhibited by G. H. Earle, of Didsbury, Manchester. This was to 7 mm. scale, and was a working model which included a replica of the last type of tram built in Manchester.

And then, of course, there was that gorgeous roundabout, with its colour and its gaiety, its sparkle and its organ music, its whiff of steam and coal smoke and hot oil, and its memories of days long gone. Surely Mr. Slack is a happy man : he has toiled nine long years to create this model, but in enjoying himself, he has given, and will give, pleasure to thousands of others. And what more could a man wish for ? I ask you !

# An original long-case clock

(*Continued from page 435*)

touch of the finger on the great wheel will cause it to rotate. The fly has an ordinary pinion working with a contrate warning wheel. Both sets of hammers are entirely fabricated, the flat steel portions that fit the slots in the hammer frame were cut from steel plate and carefully filed up and finished by hand. Holes were drilled and tapped 12 B.A. in their upper edges, the steel hammer stems being screwed to fit the tapped holes and the other ends screwed to fit the brass hammer heads.

All the various cocks, bridges, hammer spring frames were all built up and mitred where necessary, all the joints being silver-soldered, no castings of any kind being used in the movement. It took about six months to complete the chiming, striking, and musical part of the clock. The complete clock movement was then set up in the workshop for test, without any protective cover, whilst the construction of the case and dial was put in hand. The dust was, if anything, encouraged to settle on the movement, but it stood all this for a couple of months, till the case was finished, and never faltered in its various functions.

In the event of a sufficiency of enquiries, it might be possible, subject to the Editor's approval, to publish scale working drawings and instructions for making the clock, which had the honour of being awarded the Dr. Bradbury Winter Memorial Challenge Cup at the 1952 MODEL ENGINEER Exhibition, the honour being the more appreciated, as Dr. Bradbury Winter was himself a precision worker of note in the field of model engineering.

# READERS' LETTERS

**● Letters of general interest on all subjects relating to model engineering are welcomed. A nom-de-plume may be used if desired, but the name and address of the sender must accompany the letter. The Managing Editor does not accept responsibility for the views expressed by correspondents.**

### BOILER INSPECTORS

DEAR SIR,—Mr. Austen-Walton is surely in error in his article in the March 5th issue of THE MODEL ENGINEER. Board of Trade Inspectors do not inspect Lancashire boilers, they confine their activities to marine boilers, except after boiler explosions, when they inspect any type of boiler. Board of Trade (now Ministry of Transport) Inspectors are known as Surveyors.

Yours faithfully,
"SURVEYOR."

### FLUORESCENT LIGHTING

DEAR SIR,—In case previous technical reports may have dissuaded some readers from installing fluorescent lighting over their lathes, may I report (as a layman) that a simple self-contained eighteen-inch unit was hung on the picture rail four feet above my ML7 six months ago.

In subsequent use, the light has proved delightful, and well worth its £5 cost. Normal room lighting provides general illumination, and the fluorescent light is purely for the lathe and adjacent Cowell drill. I find that a green eyeshade is restful.

No rotating chuck has ever appeared to be stationary, almost to my disappointment !

Yours faithfully,
Reading. P. N. ISAAC.

### HISTORIC OSCILLATING ENGINES

DEAR SIR,—As one who is interested in historic types of engines, and one who for many years has been interested in the pioneer work of Dr. Ernst Alban, may I congratulate Mr. G. B. Round on his interesting article in your issue of February 26th. I am not so fortunate as Mr. Round in possessing a copy of Dr. Alban's book, but I have spent very many hours over borrowed copies, first a German one where, as my knowledge of German is practically nil, I had to make great use of the universal language of drawings, and later with the excellent translation of William Pole, which I regard as a most fascinating book. Mr. Round has made a most judicious selection of interesting points from it. The valve gear is very interesting, as showing the possibilities of expansive working in an oscillating engine without the use of an eccentric, which seems to be little known to model makers, though several other methods were also used by continental builders, in some of which the ratio of expansion could be varied at will. None provided any lead, however, unless some form of eccentric or cam was incorporated.

Although the particular example is not an oscillating engine, I can understand Mr. Round's desire to include the little single-acting beam engine which also fascinated me, so much so that, about eighteen months ago, I made a drawing for a proposed model from the drawing in the book. I, also, regretted that no scale was given for this engine, but my "guess" at its dimensions, made after only many hours' study of the book, was rather larger than Mr. Round's, as I decided it was approximately 6 in. bore by 18 in. stroke, and my proposed model was to a scale of 1 in. to 1 foot, that is to say ½ in. bore × 1½ in. stroke.

As I have not the book by me at the moment, I cannot now give all the reasons I had for this decision, but I know I gave the matter very much thought. One point is that the engine was single-acting only, while all other engines described were double-acting, also it would obviously have a rather slow speed. Dr. Alban's comments on horse power are most interesting, and very "practical," where he details the actual number of horses displaced by some of his engines. His boilers are also very interesting, and he was of course the German counterpart of Trevithick in England, and Oliver Evans in America, in advocating "high-pressure" steam.

The ornate design of his engines is interesting, with the fluted lagging to the cylinder to match the fluted columns, and I am glad Mr. Round mentioned his use of an oak cornice for the entablature of the oscillating engine.

Can anyone tell me what type of valve was used on the Joyce pendulous engine, of which a very large number were built in the middle of last century ? Many details of these engines are available, but no view of the inside of the valve-chest. The external arrangements of the gear were very similar to the Alban engine, but the valve spindle went into the upper part of the steam-chest. Great economy was claimed for these engines, which were made both as single cylinder engines and compounds, so I think they must have had some means of expansive working.

Yours faithfully,
Norwich. GEOFFREY K. KING

### CALCULATING DEPTH OF THREADS

DEAR SIR,—When cutting screw threads, the amount which the tool has to be entered to make a full thread, can be read from THE MODEL ENGINEER "Screw Threads and Twist Drills." If the top-slide has been set over to 27½ deg., the tool will have to travel farther, by the difference between the hypotenuse and base of a 27½ deg. right-angled triangle.

The cosec of 27½ deg. is 1.126 : so, the extra travel which has to be applied when using the top-slide is one-eighth of the depth of the thread.

Yours faithfully,
Crowborough. J. C. DAVIS.

### CORE PRINTS

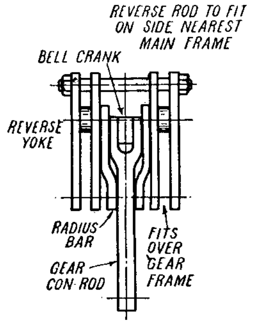
DEAR SIR,—I read the query and reply *re* patterns, and as a moulder of 30 years' experience, I would like to point out that the length of print should be at the very least ¾ in. longer than the proposed hole in the casting. This is for the purpose of balance. If it is only the same length, the core tends to drop to the bottom of the mould, and that is where you get a sloping bore. In another case you may find that the moulder has had to insert a sprig in the bottom half of the mould to keep the core from tipping. I can also state that provided the core print is dead size in circumference to the proposed core, and that the print is longer than the proposed bore, you should get a straight and concentric hole.

Yours faithfully,
Northampton. C. SMITH.

# BAKER VALVE-GEAR FOR "PAMELA" AND "DORIS"

## By "L.B.S.C."

THIS week, by kind permission of the Knight of the Blue Pencil, I propose to give a brief description of how to fit the Baker valve-gear to *Pamela* and *Doris*, in fulfilment of a long-standing promise. As both these locomotives have a similar arrangement of cylinders and motion, we can settle two sparrows with one



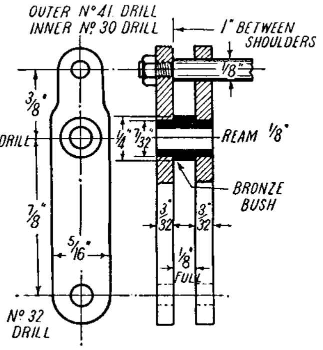

*End view of gear assembly*

shot. There is no need to make a song and dance about the job, because it isn't so long ago, that I described the Baker valve-gear as fitted to *Juliet No.* 2; and as the parts of this gear are "standard" for any engine of a given size, detailed repetition only uses up valuable space. Now, as a demonstration of the fact that I practise what I preach, about the presentation of valve-gear drawings, here are reproductions of the whole bag of tricks; both the general arrangement, and detailed illustrations of the various components. There is no jigsaw puzzle business about it, either, because you can see exactly how everything should be made, and where to fit the pieces when they are completed; the words and music will produce the melody all right !

**General Description**

The parts of the gear are carried in a girder frame, same as the Walschaerts gear, and this is supported by two brackets. The front one has to be very long, to clear the leading coupled wheel (see plan view) but the back one is short, and goes direct to the main frame. There is no need to interfere with the original guide-bar brackets, as the gear frame supports are entirely independent. The parts of the valve-gear can be made, and erected in the gear frames, before the latter are attached permanently to the engine.

The same type of connections as with a Walschaerts gear is used; but what is known as the radius-rod on the Walschaerts, becomes the valve-rod on the Baker, and is coupled to the lower end of the bell-crank. The eccentric-rod is also all-present-and-correct-sergeant, but the front end is attached to the lower end of the gear connecting-rod, in place of the swinging Walschaerts link. The return crank is a little longer, as the end of the gear connecting-rod swings through a bigger arc than the link tail. The



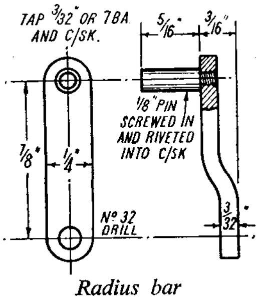

*Reversing yoke*

reverse shaft is entirely separate from the valve-gear, and is located between the driving and trailing wheels on *Pamela*. On *Doris*, or any other engine in which the firebox is between the frames, the shaft would have to go behind the firebox, as specified for the 0-6-0 tank engine *P. V. Baker*, and the two side reach-rods lengthened to suit. I have not included a separate drawing of this, as there are plenty enough shown, as it is, for one instalment of these notes; but will oblige later on, if there is any call for it, and the K.B.P. raises no objection. All the working parts can be placed below the running-boards or side platforms, and the only projection through them is the top of the left-hand reverse arm, to enable it to be connected to the reach-rod from the cab. A simple slot is all that is needed.

**Gear Frames**

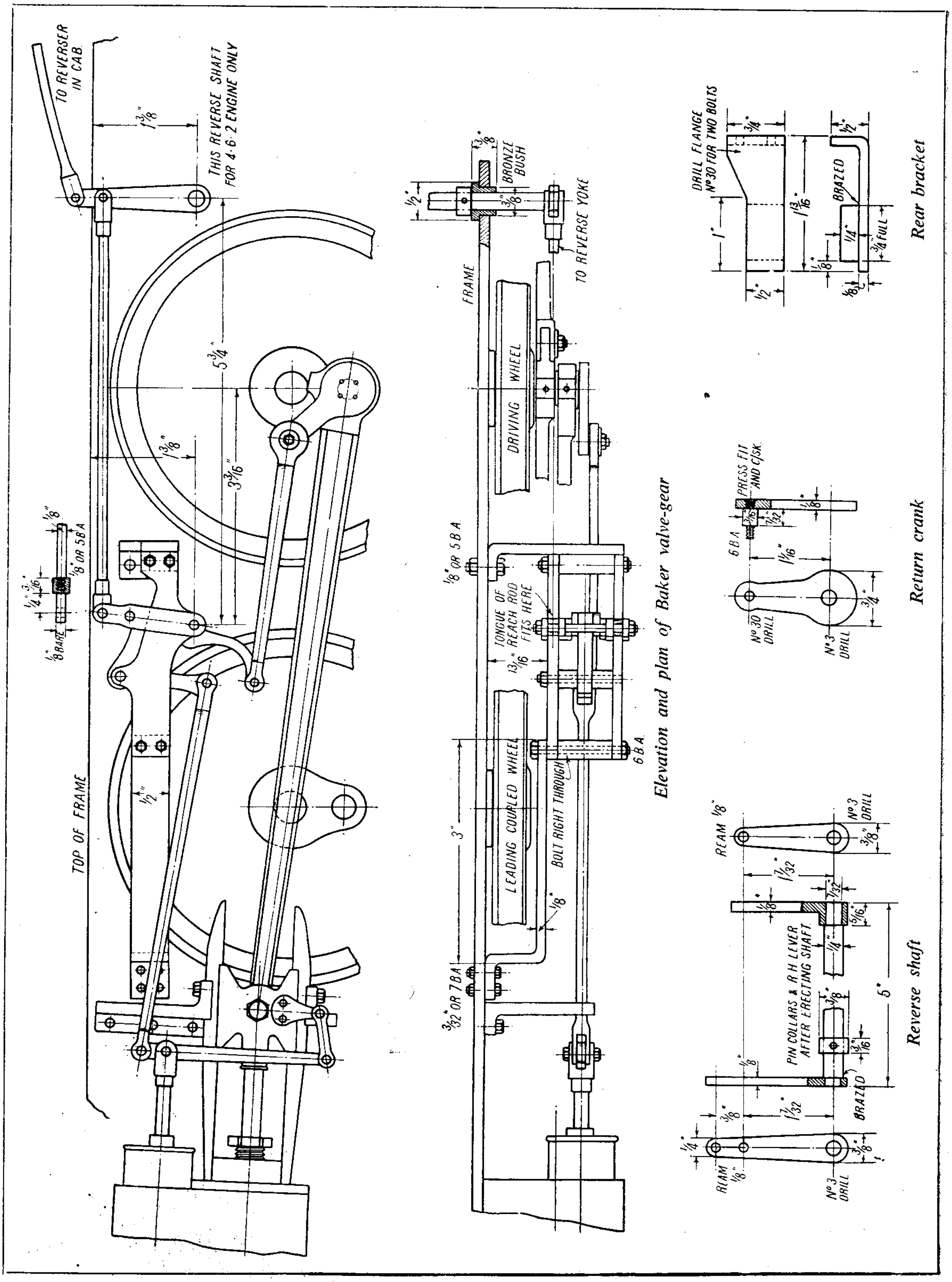
The gear frames are cut from $\frac{1}{8}$-in. soft mild steel; anybody who has a milling machine can do the whole four at one fell swoop. Note that the outer hole for the bell-crank spindle is drilled No. 21, and the inner, No. 30; a glance at the plan view will explain why. Face off the two end spacers together, in the four-jaw, to ensure the sides of the gear frames being parallel. The front one has two No. 41 holes drilled lengthwise through it, for bolts, and the rear one can either be drilled in the same way, or tapped for set-screws, as shown in the alternative detail. The rear spacer is brazed or silver-soldered to the rear bracket; the latter is merely a piece of $\frac{3}{8}$-in. × $\frac{1}{8}$-in. steel, bent as shown, and bevelled off with a file. A $\frac{1}{16}$-in. rivet will hold the spacer to the bracket whilst being brazed; file the head off after the job is done.

The front bracket is a piece of $\frac{1}{2}$-in. × $\frac{1}{8}$-in. strip mild-steel, bent to shape and dimensions shown in plan view. It is attached to the gear frame by the same bolts which hold the frames and spacer together. These can be made from bits of




*Radius bar*

3/32-in. silver-steel, screwed and nutted at both ends. Drill the holes in the brackets for the screws attaching brackets to main frame; then the brackets can be attached to the gear frames, and the whole



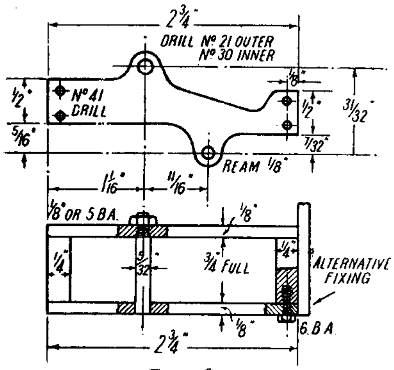

*Elevation and plan of Baker valve-gear*

*Rear bracket*

*Return crank*

*Reverse shaft*

assembly temporarily erected on the main frames. Set it with the bottom hole in the gear frame (which carries the fulcrum pin of the reverse yoke) 3 3/16 in. ahead of driving-wheel centre, and 1 5/8 in. from top of frame. The long bracket should be parallel with the top edge of main frame. Clamp temporarily in position with a couple of toolmakers' cramps, and




*Gear frame*

use the holes in the brackets as guides to drill the bolt holes in main frames. Then, when the working parts of the valve-gear are assembled in the gear frames, all you have to do, is to put the whole bag of tricks in position, and put the little bolts in.

**The Working Parts**

To make and fit the various parts that go inside the gear frame is merely a matter of filing the parts to shape, and drilling holes, which is a much easier task than making curved and slotted links, and fitting dieblocks. All the dimensions are given in the accompanying illustrations, so only a brief mention will be necessary. The reverse yokes are double, and each pair are permanently connected by a stepped bronze bush turned from 1/4-in. rod, and squeezed into 7/32-in. holes drilled in the yokes. They should be a full 1/8 in. apart, so as to fit easily over the gear frames; see end view. The tie-bar at the top, which keeps the upper ends at the proper distance, and rigidly connected, is made from 1/8-in. round steel, reduced to 3/32 in. at the ends, and screwed; the distance between shoulders should be 1 in. Note: the tie-bar passes through the inner side of the yoke, which is drilled No. 30 for this purpose; and the outer side is drilled No. 41, so that the screwed part can pass through, and the nut used to hold it tight to the shoulder, see section. Ream the bushes 1/8 in.

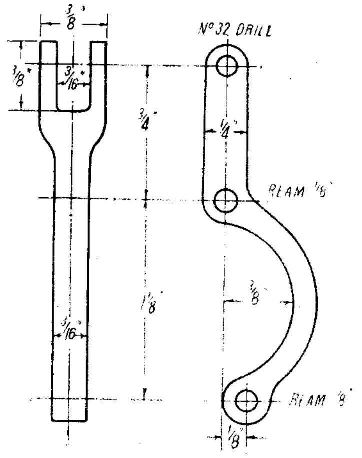
The pins on the radius bars must be a nice working fit in the stepped bushes in the reverse yokes. I usually find that 1/8-in. silver-steel works perfectly in a 1/8-in. reamed hole, but reamers vary—perhaps I'm lucky! Screw the pin tightly into a tapped and countersunk hole in the top of the bar, rivet over, and file flush. Be sure to get the "set," or bend, correct in all four bars. The bell-crank is cut from 3/16-in. steel plate, and the bush turned from 1/4-in. bronze rod; if it is made a squeeze fit in the bell-crank, it needn't be silver-soldered. The gear-connecting rod can be cut from 3/8 in. × 1/4-in. mild-steel bar, and bent to shape, care being taken to get the offset right; the exact radius of the "sickle" part doesn't matter so much, as long as the bottom end of the bell-crank doesn't touch it when they approach each other in full back gear. All the working pinholes in every part should be reamed, as indicated, and may with advantage be casehardened, by the process described for *Tich* valve-gear parts. Alternatively, they may be bronze-bushed.

Those good folk who find it a fiddling job to file out little bits, and squeeze in little pins and bushes, can dodge most of the work by purchasing the little castings as sold by our advertisers who supply parts for my engines. Reeves does all the working parts for Baker valve-gear in malleable iron, and these look exactly like the drop stampings used in the full-sized article, so should please Inspector Meticulous; and I can testify that they save work. At the time of writing, he has only produced the bracket-type gear frame (as used on *Juliet No.* 2) as a gunmetal casting, but should be able to supply the girder frame complete with attaching brackets, as one unit, in the near future,; and I'm open to bet that the chieftain of Clan McWilwau won't be far behind if he doesn't get in front, says Pat. Kennion's will probably chip in as well, so there should be plenty to choose from!

**How to Assemble the Gears**

This is easier than taking a pill. All the pins are just short lengths of 1/8-in. silver-steel, and if slightly bevelled at one end, can be squeezed in readily; it doesn't matter about the exact length, as they can be filed flush after the squeezing process. Put the upper end of the bell-crank in the fork of the gear connecting-rod (mind you have the "sickle" with the convex side away from the bell-crank) and squeeze a pin through the joint. Next, put a radius bar each side of the gear connecting-rod, and pin through the lot. Put the tie-bar through one side of the reverse yoke, and screw on the nut tightly, then put the reverse yoke over the pin on the radius bar. Put on the other reverse yoke, over the other pin on the opposite radius bar; but before entering the tie-bar into the upper holes in the reverse yoke, make the two little tongue pieces, as shown over the top of the gear frame assembly in the general arrangement drawing. The tongue should fit the space between the two plates of the reverse yoke, and have a No. 30 hole drilled in it, to allow the tie-bar to pass through; the boss should be 7/32 in. diameter, and tapped either 1/8 in. or 5 B.A., to suit the end of the short reach rod. Put the tongue between the sides of the reverse yoke, and run the tie-bar through the lot, nutting up on the outside of the reverse yoke, as shown in the end view of the gear assembly. The tongue should be on the side of the reverse yoke that is nearest to the main frame, when the complete valve-gears are erected.

Drop the assembly between the gear frames, so that the reverse yoke straddles each side of the frame; line up the holes at the bottom of the yokes, with those at the bottom of the frames, and squeeze a pin through each side. Line up the bell-crank bearing with the holes in the upper part of the gear frame, push the 5/32-in. spindle through the lot,




*Gear connecting-rod*

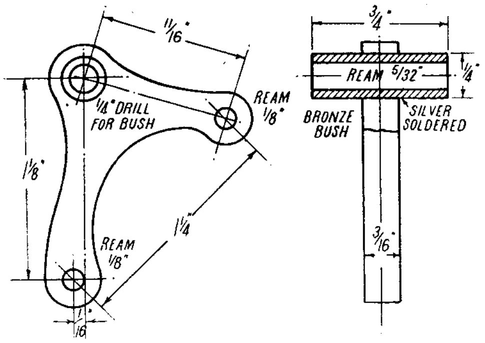
and fix it with a nut outside the gear frame, as shown in the plan views. The reverse yoke should now be able to swing back and forth readily; doesn't matter if it is a shade on the tight side, as it is hand-operated from the cab reverser. If the gear connecting-rod is waggled back and forth, with the reverse yoke at either

end of its movement, the bell-crank should move easily, and there shouldn't be any shake in the joints. The whole issue can then be placed in position against the main frames, and bolted up through the holes already drilled.

**Valve-rods and Eccentric-rods**

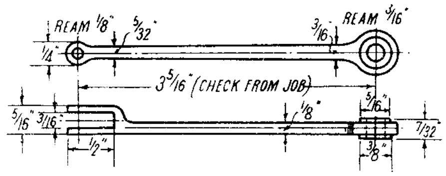
To get the exact length of the valve-rod, proceed as follows. Incidentally, if anybody tells you he can put up a valve-gear straight from the drawing-board, and *get perfect setting*, ask for a pinch of salt, for the man who can do that, isn't born yet, and I doubt if he ever will be. Set the main crosshead in mid-travel and the valve in mid-position. Put the reverse yoke in such a position, that when the gear connecting-rod is waggled back and forth, the bell-crank doesn't move. The distance between centres of holes in top of combination lever, and bottom of bell-crank is the distance between the centres of holes in the valve rod, which can then be made as per drawing, and attached to bell-crank and combination lever, by little bolts made from $\frac{1}{8}$-in. silver-steel. Shoulder these down at each end, to 3/32 in., and screw either 3/32 in. or 7-B.A. using nuts to suit, for sake of neatness. When the nuts are tight against the shoulders, the pins should turn easily with finger pressure. Friction in valve-gears should be avoided.

Now make and fit the return cranks, as described for *Pamela* and *Doris*, but work to the sizes shown here, and fit them on the end of the main cranks, setting them as near as possible "by eye," to the position shown. To get them exact, also to obtain the exact length of the eccentric-rods, is a simple rule-of-thumb job. Put the gear connecting-rod in such a position, that the reverse yoke can be moved back and forth without any corresponding movement of the bell-crank. Set the main crank on front dead centre; that is, with the crosshead as near the cylinder as possible. With a pair of dividers, measure from the centre of the hole in the gear connecting-rod, to the centre of the return crankpin. Then shift the main crank to back dead centre, taking care to avoid moving the gear connecting-rod, and measure again between the same points. The measurements probably won't tally—it will be miracle if they do !—so shift the return crank on the main crankpin, enough to move the return crankpin half the difference between the measurements, and try again. The third shot usually "bunnicks the cod," as the Victorian school-children would have said; they had a language of their own, which grown-ups didn't always understand, but which was more picturesque and amusing than present-day "picture slang." Anyway, when the distance between the centre of the hole in the gear connecting-rod (set as above) and the centre of the return crankpin, is exactly the same when the main crank is on either front or back dead centre, the return crank is correctly set, and the distance between the divider points is the exact length of the required eccentric-rod. Pin the return crank *a la* the *Pamela* or *Doris* instructions, and proceed to make and fit the eccentric-rods as per the reproduced drawing, using the already-set dividers to locate the pin-holes. The pressed-in bronze bush in the larger end of the eccentric-rod (made large, to simulate the ball-bearing housing on the full-sized engines) should be reamed to an exact working fit on the return crankpin, which will ensure good valve events; the fork is attached to the gear connecting-rod by a little silver-steel bolt, as mentioned above for the valve-rod forks.

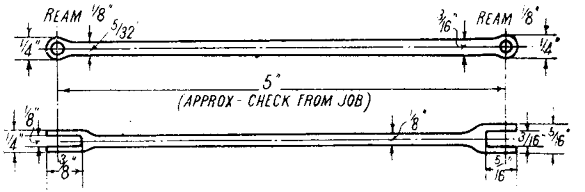



Bell crank

Right—Valve-rod




*Eccentric-rod*




With the valve-gear made, erected and set as above, the only adjustment needed to ensure that the ports open and shut correctly, is to get the right position of the piston-valve on its spindle, and this is merely a matter of trial and error. When the reverse gear is in mid-position, so that the bell-crank remains stationary when the wheels are turned by hand, the only movement given to the valve spindles, is by the action of the combination lever; this opens the ports to lead, at each end of the stroke. All you have to do, is to adjust the valve on the spindle, by means of the lock-nuts, until the hiss from the cylinder cocks, as the crank passes dead centre, with air (supplied by a tyre pump) in the steam chests, is equal at both ends of the stroke. The hiss should start just a weeny bit before dead centre is reached, and cease the same distance past the dead centre. The valve-gear looks after the rest of the business.

**Reversing Shaft and Connections**

All that remains, is to connect up the two sets of valve-gear to the cab reverser. For this purpose we need a reverse shaft, that corresponds to the weighbar shaft of a Walschaerts or other gear, so that both sets of motion are operated simultaneously; and in the case of *Pamela* this can be located at $5\frac{3}{4}$ in. behind the centre of the reverse yoke pivot, and $1\frac{3}{8}$ in. from the top of frames. Mark off and drill a $\frac{3}{8}$-in. hole at this point, in both main frames; and in them, fit bronze bushes (flanges inside frames) made from $\frac{1}{2}$ in. round rod, as shown in

(*Continued on page* 449)

# IN THE WORKSHOP

BY DUPLEX

# AN ELECTRIC MUFFLE FURNACE

THE small electric furnace described in THE MODEL ENGINEER of December 11th, 1952, proved so successful that it was decided to make a larger muffle furnace, on the same lines, suitable for case-hardening components of moderate size, and for hardening tools too large to go into the original muffle.

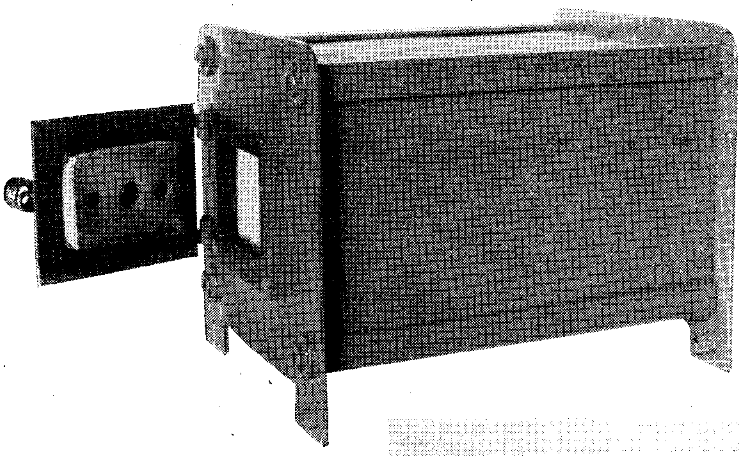


*Fig. 1. The finished muffle furnace*

The prototype furnace aroused interest at last year's MODEL ENGINEER Exhibition, and we are grateful to those visitors and correspondents who have told us where supplies of the special materials needed for the construction of the present furnace could be obtained.

The new furnace has a consumption of approximately 800 W, and the muffle itself, that is to say the heating chamber, has an internal length of $6\frac{1}{2}$ in. and is 3 in. wide by $2\frac{1}{2}$ in. in height.

In our country district, the voltage of the public electricity supply often falls to 190 V; nevertheless, the furnace reaches a temperature of 1,000 deg. C. in about 30 minutes, and this is more than enough for case-hardening, or for hardening carbon-steel components. For working above this temperature, special materials are usually required for the construction, if satisfactory service is to be obtained. A larger heating chamber can, of course, be installed, but this means greater initial expense and higher running costs. As in the small prototype furnace, the heat is controlled by a Simmerstat thermo-switch, and an easily-made pyrometer to give approximate readings of the internal temperature will also be described.

Where a special material is specified, the manufacturer's address is given, solely in order to help readers, and forestall written enquiries.

### The Heating Chamber or Muffle

The heating chamber fitted to the furnace is a Vitreosil muffle, manufactured by the Thermal Syndicate Ltd., of Wallsend, Northumberland, and is 7 in. in length outside, by $3\frac{1}{2}$ in. wide and 3 in. high; one end is closed.

Vitreosil consists of fused silica, and has the advantages that it is resistant to heat up to a temperature of 1,100 deg. C., and is an efficient electrical insulator. The heating element itself is formed of forty turns of No. 24-s.w.g. Nichrome wire, obtainable from The British Driver-Harris Co. Ltd., Albion Street, Manchester, 15.

The wire is wound directly on to the outside of the muffle, with a

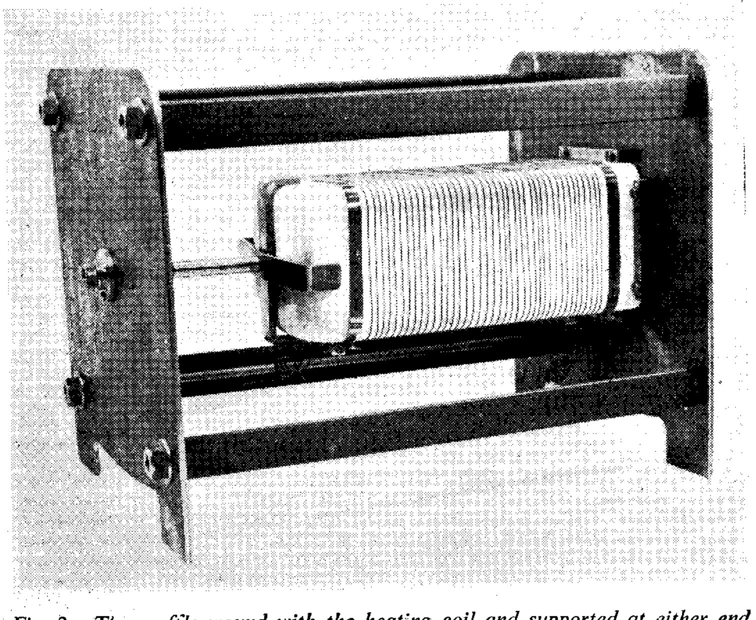


*Fig. 3. The muffle wound with the heating coil and supported at either end*

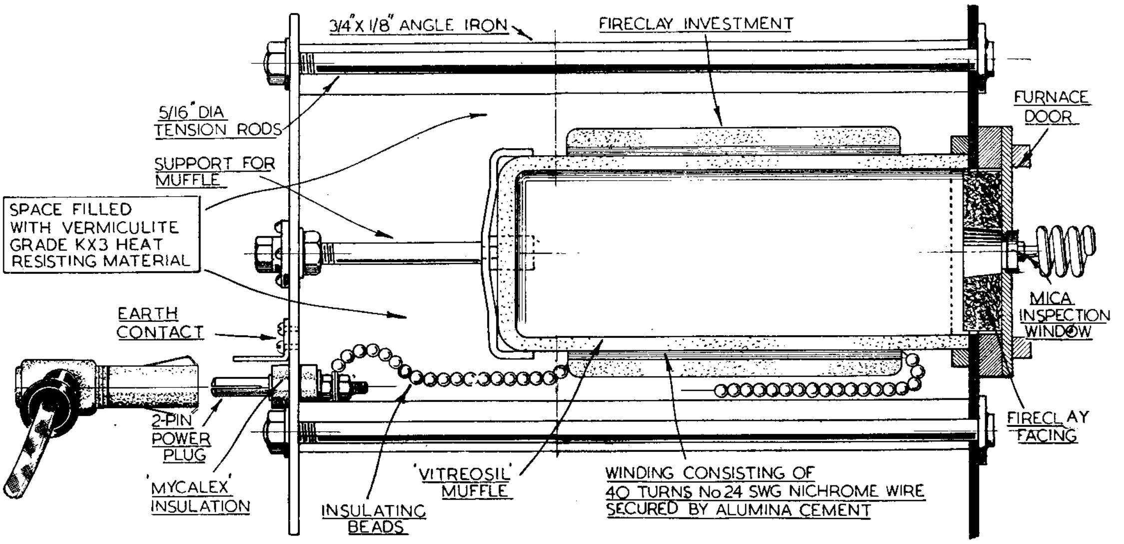



*Fig. 2. Sectional view of the furnace, showing the internal construction*

spacing of $\frac{1}{8}$ in. between turns, and the wire is secured at either end by means of a clip made of thin steel strip, of the kind used for fastening packages in transit. For keeping the wire turns in place, the element is covered with a layer of Alumina cement to a thickness of about $\frac{3}{16}$ in. this material is also supplied by the Thermal Syndicate Ltd.

After being mixed with water to form a thick paste, the cement is best applied with a paint brush to fill the crevices and form an even covering. Before the full current is supplied to the heating coils, the cement must be thoroughly dried by passing an alternating current of low amperage; for this purpose, the wiring can be connected in series with electric light bulbs so as to warm the coils.

As shown in Fig. 2, the Alumina cement is next covered with a layer of fire-clay or Pyruma cement, to a thickness of from $\frac{1}{2}$ in. to $\frac{5}{8}$ in., and the drying process is repeated. Any cracks appearing in the outer layer of cement should be afterwards filled in.

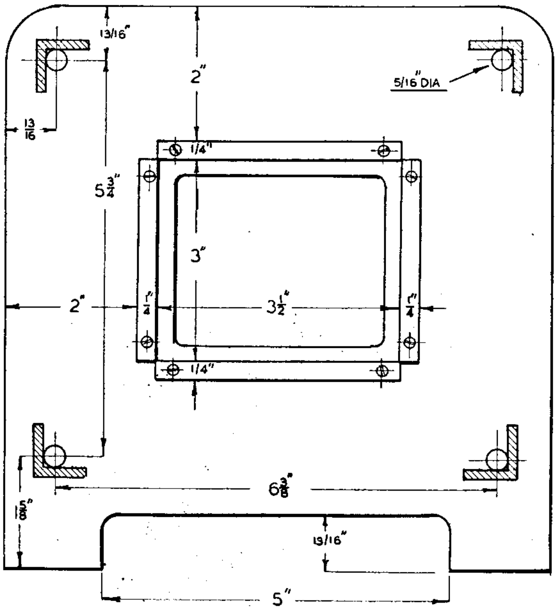



*Fig. 4. The front plate and muffle supporting frame*

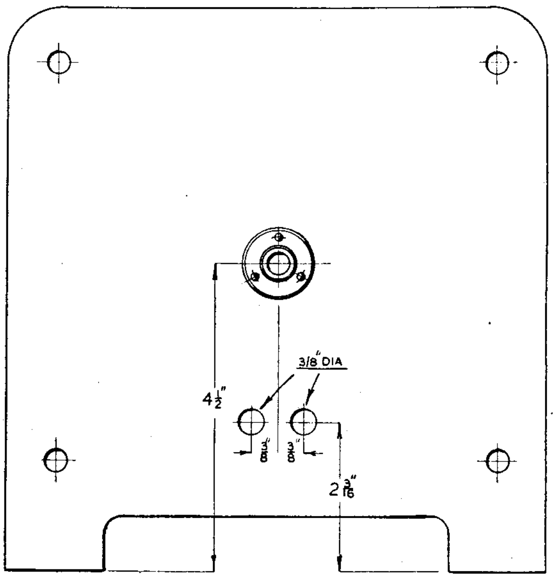



*Fig. 5. The furnace back plate*

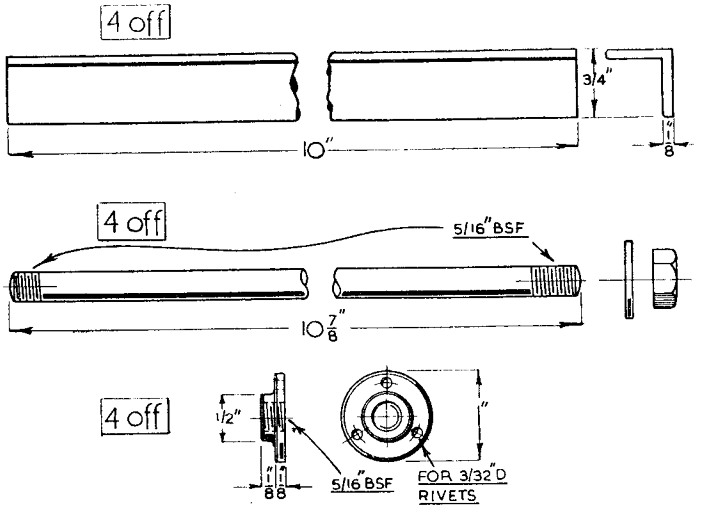



*Fig. 6. The angle-iron distance-pieces and the stretchers with their bushings*

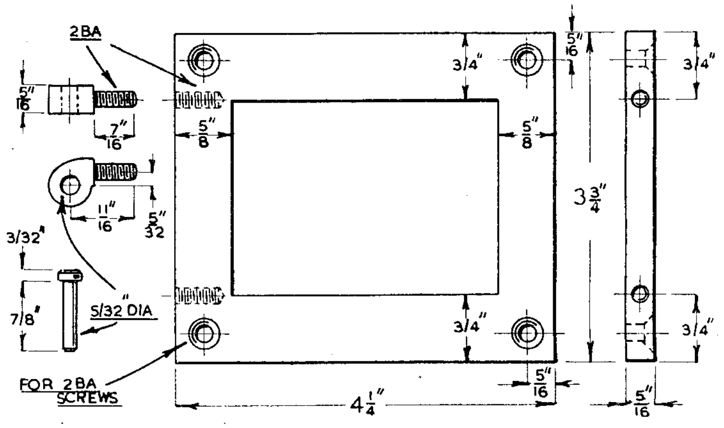



*Fig. 7. The door frame and hinge parts*

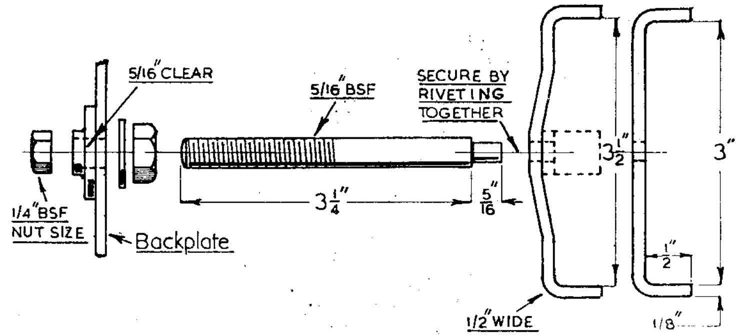



*Fig. 9. The support for the rear end of the muffle*

### The Furnace Casing

The front and back of the furnace are cut from $\frac{1}{8}$-in. steel plate to the shape shown in Figs. 4 and 5.

The viewpoint in Fig. 4 is from within the furnace, and shows the built-up frame, also seen in Fig. 2, needed for supporting the outer end of the muffle. As shown in the accompanying illustrations, the back- and front-plates are held together by stretchers, pulling the plates against angle-iron distance-pieces.

Either rod or steel tubing can be used for making the stretchers; one end screws into a threaded bushing riveted to the front-plate, and a nut and washer are fitted at the back.

### The Fire Door and Frame

The furnace door is hung on the frame shown in Fig. 7. This frame is cut out from $\frac{5}{16}$-in. steel plate and is fixed to the furnace front with 2-B.A. countersunk-head screws. The two eye-bolts forming the hinges are either made in one piece or they can be built-up by screwing a 2-B.A. stud into the eyed portion. The holes for the pivot pins should, at this stage, be drilled undersize, as, when fitting the door, a reamer is put through both parts of the hinge with the door closed evenly against its frame. For the door, $\frac{1}{8}$-in. steel plate is thick enough. To save labour and material, the hinges are best bent to shape while hot. The inspection window consists of a mica disc held in place with a split ring.

The fireproof lining of the door is formed of Pyruma cement, moulded to shape and secured in place with screws. An easy way of making the lining is to use the door frame as a mould, and the necessary clearance is obtained by packing the frame with strips of thin wood. A short length of metal or cardboard tube will serve for moulding the central hole opening on to the inspection window; no difficulty will be found in drilling the holes for the attachment screws after the material has dried. Before being subjected to the full heat of the furnace, the lining must be baked at a moderate temperature in order to avoid cracks forming. The door handle shown in Fig. 8 is made from steel or brass rod, twisted to form a pig-tail; this will keep the handle from becoming uncomfortably hot.

### Mounting the Muffle

As already stated, the front end of the Vitreosil muffle fits into the frame built up on the inside of the front-plate .The rear end of the chamber is supported by the fitting

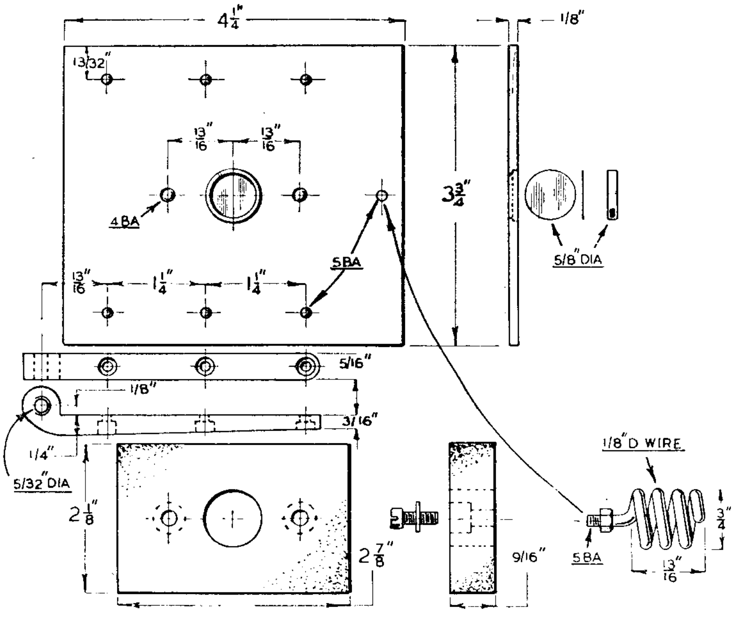



*Fig. 8. The fire door, strap hinges, door lining, and handle*

illustrated in Figs. 3 and 9. The two forks of the support are secured in place by riveting over the end of the central rod, and the outer fork is given a set to allow it to bear evenly on the end of the muffle. The rod passes through a bushing riveted to the backplate, and a nut on either side provides a means of adjustment for length. At this stage, the muffle can be mounted in position; the casing is stood on its end and the muffle support is put in place. After engaging the front end of the muffle in its frame, the support is lowered, and then secured by tightening the two nuts on the rod, but to allow for heat expansion, the two forks should clear the end of the muffle by $\frac{1}{8}$ in. or so.

The furnace has now reached the stage depicted in Fig. 3, except that, there, the heating coil has not been covered with insulating material; the next step will be to connect up the wiring, and after that the casing will be completed and then filled with a special heat-insulating preparation.

*(To be concluded)*

# BAKER VALVE-GEAR FOR "PAMELA" AND "DORIS"

*(Continued from page 445)*

section on the plan drawing of the whole doings. A tight push fit will do; they can't come out, as the collars on the shaft prevent any of those antics.

The shaft itself is a 5-in. length of $\frac{1}{4}$-in. round steel (mild or silver) faced off at both ends. Turn down $\frac{5}{16}$ in. of one end, and $\frac{1}{8}$ in. of the other, to 7/32 in. diameter. On the latter, fit and braze the longer of the reverse arms, which is cut from $\frac{1}{8}$-in. × $\frac{3}{8}$-in. mild steel, and drilled as shown. The arm on the other end is cut from the same kind of material; but as it has to be adjustable, it is furnished with a $\frac{3}{8}$-in. boss, brazed on and drilled as described in the *Tich* instructions. It should be a tight fit on the end of the shaft. Two collars are also needed, made from $\frac{3}{8}$-in. rod, and a sliding fit on the shaft.

To erect, push the shaft through the left hand bush, put on the two collars between the frames, push shaft through the other bush, and press on the shorter arm, in line with the longer one. Connect the arms to the bossed tongue-pieces in the tops of the reverse yokes, by pieces of $\frac{1}{8}$-in. round steel, with forks, screwed on to the rear ends; the forks are made from $\frac{1}{4}$-in. square steel rod, in the same way as valve-gear forks. The distance beween the centre of the pin in the reverse yoke, and the centre of the pin in the fork, should be 5$\frac{9}{16}$ in. to bring the levers vertical in mid-gear. Set the left-hand side in mid-gear, so that the valve-rod doesn't move when the wheels are turned; then check the right-hand side. If this isn't in mid-gear also, shift the adjustable arm on the reverse shaft until it is. When both sides are in mid-gear at the same time, pin the adjustable arm to the shaft with a bit of 3/32-in. steel squeezed through a No. 43 hole drilled through boss and end of shaft. Run the collars up close to the flanges each side, as shown in the plan drawing, and pin them with bits of $\frac{1}{16}$-in. steel wire squeezed through No. 53 holes drilled through bush and shaft.

The same type of cab reverser can be used, but the screw will have to be lengthened, to suit the extra movement needed by the reach rod, to obtain full forward and backward gear positions; the reach rod is similar, but shorter. The exact length is obtained from the actual job, by setting the reversing nut in the middle of its travel, setting the longer reverse arm vertical (see elevation) and measuring from the centre of the hole in reverse arm, to the pin on the nut. In the case of *Doris*, or any other engine where the firebox prevents the use of a reverse shaft in the position shown, the easiest thing to do, would be to dispense altogether with the screw reverser, and use a pole lever. This could be pivoted on a rod running right across the frames, and furnished on the right-hand side, with a shorter reverse arm, like that shown in the drawing. The lever itself would take the place of the longer arm, and would be coupled direct to the left-hand set of valve gear, by a long round reach rod attached to the lever by a fork, as specified for *P. V. Baker*.

Well, there you have a brief (but I sincerely hope lucid) synopsis of the whole job, with no "old buck" or "trimmings" about it. Anybody who can work to simple drawings, should be able to equip a locomotive with the Baker valve-gear. One of the three experimental jobs I now have in hand, is fitted with this gear—or rather will be, when the job gets finished !—and if she performs as well as the other Baker-geared engines in my fleet, I shall be well satisfied; so that will be all for today, thank you !

# TWIN SISTERS

## by J. I. AUSTEN-WALTON

I HAVE found an omission from the boiler general arrangement, fortunately not a very serious one ; it concerns the staying of the firebox door plate to the backhead. If you look at the separate detail of the door plate in this issue and compare it with the view of the backhead already described, you will see that an additional pair of tapped holes appear a little way above the group of four holes that are obviously meant to fix the door in place—in other words, the very top pair of holes. The holes that correspond to these in the backhead, were left out, so it should be an easy job for you to transfer them through ; those same holes in the backhead will not be tapped, however, but drilled clearance, just like all the other stay holes in the outer wrappers.

Whilst on the subject of the fire-hole door, the group of four holes situated round the firehole itself, makes use of the hollow stays also detailed here. These might well be brazed in place when you braze the ring in the plate. Later, when the backhead is offered up in place, you will have to see that the free ends of the hollow stays line up with the holes provided for them in the backhead plate ; there will be other threading jobs to do here—passing the two steam pipes through, the two injector feeds and the blower pipe. Once these are all through, and the steam pipe assembly is set so as to bring the manifold correctly in line with the inside of the dome, the various pads that go on the back-head may also be threaded over the free lengths of pipe that you were advised to leave, sticking out spare. This helps to keep all the pads in place when silver-soldering or brazing up.

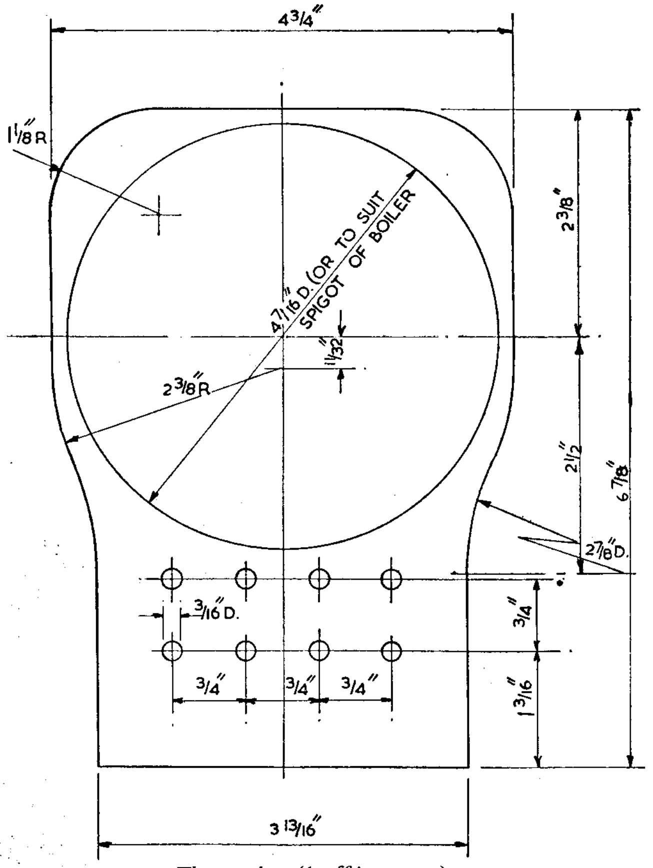
Going back a moment, the whole idea of the hollow stays is to allow you to bolt the firehole door assembly in place after all brazing is done. There are no water joints to be made, such as you would find by tapping a hole directly into the water space behind the backhead. In spite of every care, such studs do still tend to weep or leak, and although they fur up eventually, there is always the evidence about that shows traces of an untidy residue. The hollow stay allows you to use through bolts ; I use stainless steel bolts because, since they are non-scaling in nature, the heat inside the firebox does not burn them up. A good alternative to this would be to tap the hollow stays in the final stages, and fit ordinary bronze set-bolts ; there is plenty of body thickness to allow for this if desired.

The rest of the boiler parts are shown in the accompanying drawings, but there remain the various pads and bushes, grate and ashpan, the superheater elements and the firehole door fitting complete. The trouble with boiler parts is that they take up so much room. I had intended getting the entire boiler story on a couple of sheets, but now find that I am badly out.

The two firebox end plates are shown together, and unless you were reminded of the fact, you might mark these out together. Notice that there is a difference ; the thickness of the wrapper all round, 14-gauge, is taken off the door plate because it fits *inside* the wrapper whilst the tube plate follows the wrapper outside line.

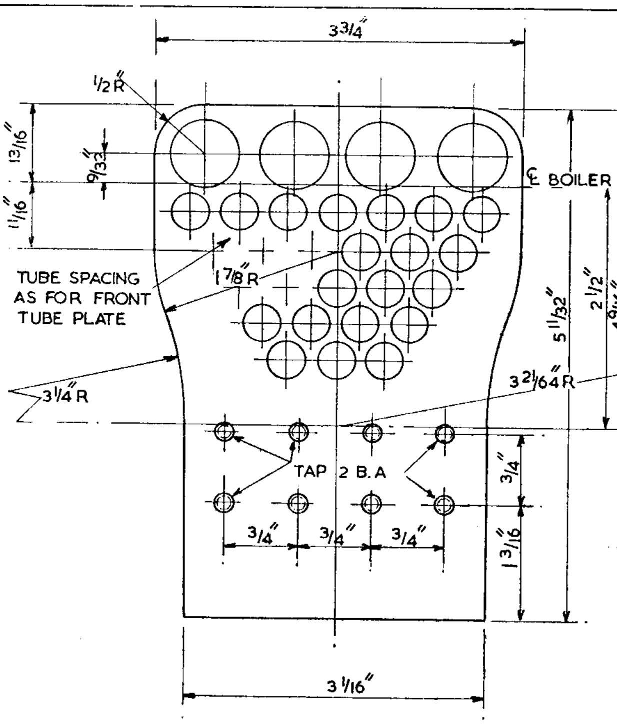
I would also like to draw attention to the throat plate, particularly with regard to the very shallow section left at the top and the two sides. As a single and separate piece it may look weak but, of course, it *isn't*. Once this is fixed to the barrel and the wrapper, all its strength is restored, and you would have to tear the copper of the plate or barrel apart, to separate them ; but I shall have more to say about this later.

The object in view when designing

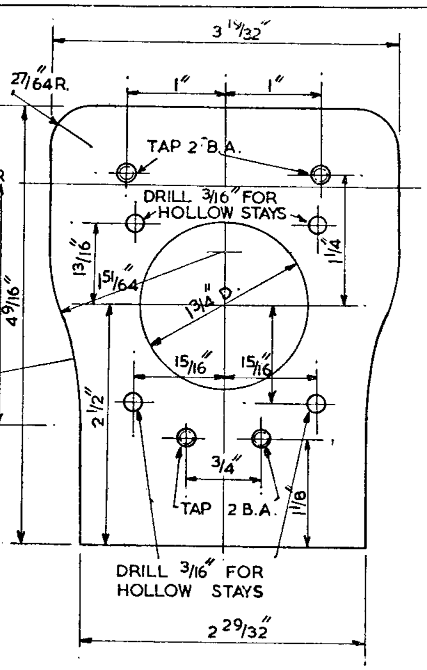



*Throat plate* (1 *off in copper*)

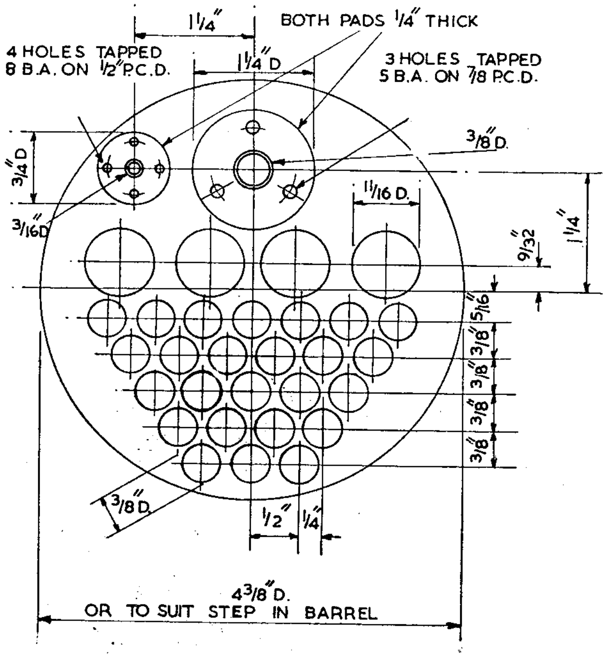
*Continued from page* 298, *March* 5, 1953.



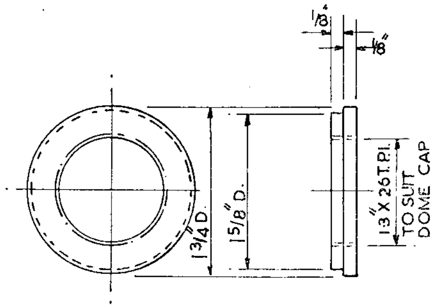

*Firebox tube plate (1 off in 14-gauge copper)*



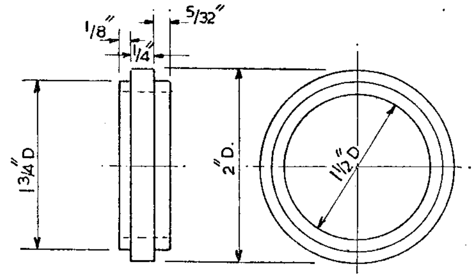

*Firebox door plate (1 off in 14-gauge copper)*




*View from front of boiler (1 off in $\frac{1}{8}$-in. copper)*

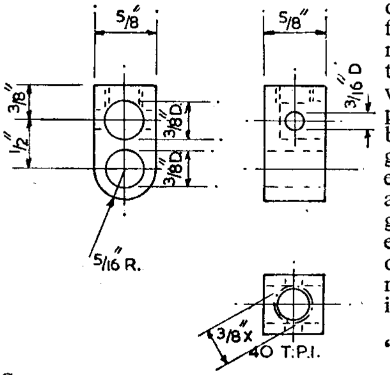



*Dome cap ring (1 off in G.M. or bronze)*




*Firehole door ring. (1 off in copper)*

the throat plate was to get the step between the barrel and the firebox, something like scale. I have seen too many engines spoiled by a simply colossal step between these parts, especially when the lagging has been added ; there is really no need for this sort of thing if we care to take the trouble to avoid it.




*Steam pipe dome manifold* (1 *off in brass or G.M.*)

**Superheaters**

I fully expect to get a few letters about the superheater tunnels being called for in $\frac{11}{16}$ in. dia. This is the ideal size for this particular boiler but may, in fact, prove difficult to get. In such cases, turn to $\frac{5}{8}$ in. dia. rather than a larger size. In any case, I doubt very much if you would get the larger size built in, without closing the group too much. As a matter of interest, brewers use copper tubing that is always measured by its inside diameter, and I believe it is drawn specially for them.

All that we have to remember is that we must get two $\frac{1}{4}$ in. dia. pipes through each tunnel, and still leave room for a solid type spearhead element. It is possible to get these pipes in a $\frac{9}{16}$ in. tunnel, but in order to do so, the ends of the pipes have to be flattened slightly where they enter the element. I did this on one occasions by making up the element in the usual way, but when the pipe holes were drilled, they were allowed to run into each other very slightly—by that I mean not more than the combined pipe wall thickness. To carry out this seemingly tricky operation, all you do is to drill one hole first, put in a temporary copper plug and then drill the other hole ; remove the plug after this, and there you are. If, after all this care, you still find the element too large to go through the tunnel, then carefully pinch it by its narrow edge in the vice jaws, but insert the two pipes before doing so or you will be in fresh trouble. Never do the pinching up operation *after* brazing, because it may overstress the joint and cause a leakage.

The reason for not wanting a larger size of tube for the tunnels, is, apart from the space question, one of relative areas. Any gas or liquid will always choose the easiest path of escape, and the hot gases in a firebox are no exception. If we make the free unrestricted area of the tunnel too great, the hot flue gases will rush down these spaces in preference to the bank of fire tubes below, with the result that we shall get very hot steam, but perhaps not enough of it. The whole idea is to arrive at a state of balance where the gases have to use every avenue of escape without causing back pressure or undue resistance ; and believe me, the problem of skin friction inside a pipe is quite a reality.

**" Dream of the Future "**

This dream of the future with regard to the fitting of simple and efficient braking on small passenger cars, and from which " L.B.S.C." suggests that I need a gentle awakening, will continue to be a dream until I see more of such fitments in use throughout the country. I think I am right in saying that less than 5 per cent. of the tracks in use have a vacuum brake on the passenger cars. " L.B.S.C." most certainly described both the vacuum and Westinghouse systems, but if they were so simple to make and so foolproof in action, why have we not seen more of them in use ?

As for the ejector part of the gear, I never suggested that the making of an efficient ejector was a *difficult* job, but I most certainly commended Mr. Marchant for *having got something done*, and done well. Mr. S. A. Ford, of Swansea, also appears to have evolved a most satisfactory system, and all honour to him.

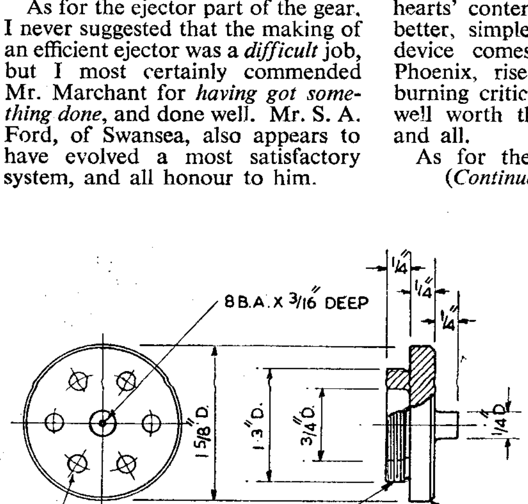
**A Simple Version of the Triple Valve**

Quoting the above verbatim from my own article, I have to apologise for not having completed the story at the time, with the result that many well-meaning folk have come down on me like a ton of bricks—but thank you all the same. The normal version of the vacuum brake needs nothing more than a simple ball-valve for its operation, whilst the true version of the Westinghouse brake entails the use of a device known as " the triple valve." My dream of the future was rather centred round the new " Beech Hurst " track at Haywards Heath, and with it, the problem of devising a braking system that would work efficiently when hauled by any type of engine that might be visiting the site.

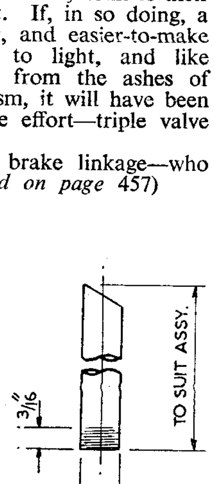
There are before me now, three different systems of vacuum brakes. The first is the normal or standard type which relies on an ejector fitting in the engine, for its operation. The other two are variations of the simple system, and allow a locomotive, *whether fitted with an ejector or not*, to operate a vacuum brake. In order to do this, *a simple form of triple valve* is put in the circuit, enabling a direct-acting vacuum unit to work the system. I had intended putting in a number of diagrams of the systems suggested, but until the present series is completed, I do not feel that the space can be spared.

I'm sorry to be such a spoil-sport about it, but later, the hounds may be unleashed and the " experts " can tear up all three systems to their hearts' content. If, in so doing, a better, simpler, and easier-to-make device comes to light, and like Phoenix, rises from the ashes of burning criticism, it will have been well worth the effort—triple valve and all.

As for the brake linkage—who (*Continued on page* 457)




*Dome cap* (1 *off in G.M. or bronze*)




*Steam collector pipe* (1 *off in copper*)

# AIDS TO ACCURACY IN MARKING-OUT

## WITH SPECIAL REFERENCE TO PROBLEMS ENCOUNTERED IN SMALL WORK

By W. T. Barker

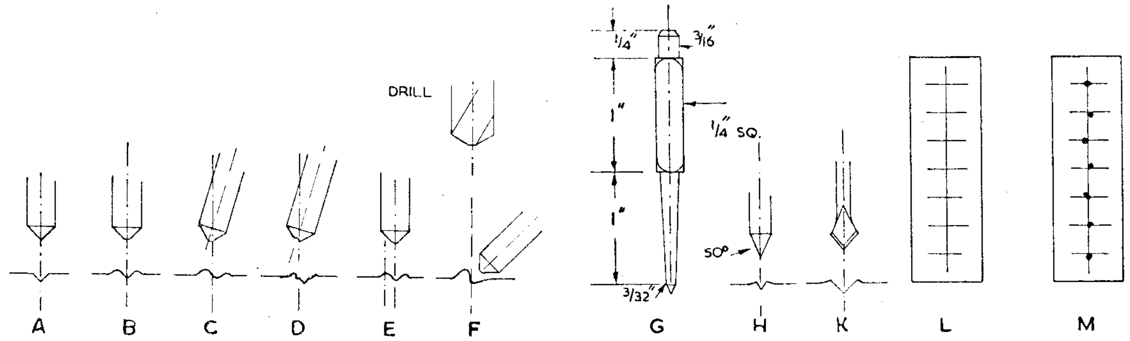
NOW and then I get asked how I put small holes in small component parts exactly where I want them and the answer is that I take normal precautions against errors, but that I am not immune to occasional bloomers in spite of them. Further investigation so commonly elicits the fact that these normal precautions are missing from the enquirier's methods and that errors both in marking off and in drilling, etc., are so frequent that perhaps some account of methods I use resulting from over 50 years' addiction to the hobby of model-making may be helpful to others.

Accuracy is only a relative term. We model makers cannot achieve the fine limits normal to present-day industry nor is it necessary. We use the methods of our grandfathers in the days before micrometers, jig-borers, slip gauges and a host of other offsets to human fallibility were invented and do our marking off with scriber, rule and square, and quite tolerably accurate work can be done that way provided reasonable care is taken, but don't imagine that it is only necessary to read notes of this sort, and then go off and do it. It is not quite so easy as that. Accurate marking off is only part of a larger whole. The best of marking off may be wasted unless the model maker can machine and file his pieces correctly to size and shape, truly flat and square where necessary beforehand. He must cultivate for instance, the capacity to "see square" and it comes only by practice. It is quite possible to train oneself to "see square" within $\pm$ 1 deg. and it is often necessary to be able to do so.

It isn't everyone, perhaps, that has these capabilities. They depend partly on physical and mental characteristics, eyesight, delicacy of touch, patience, etc. One of the closest approaches to accuracy possible to the human eye is in the visual observation of the coincidence of two fine lines: e.g. the principle of the Vernier scale. Test your own ability. It can easily be done with a minimum of apparatus. All you need is two similar graduated rules 3 in. or 4 in. long, a little piece of flat plate to rest them on, some sort of a clamp and a set of feelers. Clamp one of the rules down on the piece of plate (letting the front end of the rule project a little) on say the top-slide of your lathe so that the front end is square against the tool-slide. Draw this back just enough to be firmly in contact with the rule. Now lay the other similar rule in edge contact with it and observe—all the graduations of both rules should exactly coincide. The probability is, however, that they will not; either rules are not as well made nowadays as they used to be or perhaps irregular shrinkage in hardening affects them. Select a pair of lines that appear to you to coincide exactly—then put the 1½-thou. feeler in between the loose rule and the tool-slide, and see if you can observe any displacement—if not try 2-thou. and so on. Unless you can see definite displacement at 3 or 4-thou. you will need stronger aids to vision if you wish to improve your standards of accuracy. I made a test of myself, the first for some years, just before writing these notes and found that with a piece of 0.001 in. foil I could see no change. With the 1½-thou. leaf, I thought I could but it might have been just knowing what to expect. With a 2-thou., leaf displacement was clearly apparent. Aids to vision of course were used—spectacles and a Herbert Bino-Mag, and indeed for close marking off either this instrument or a watchmaker's eye-glass will be essential for most people.

This is the first step in the search for closer accuracy and we find that it should be possible, with due care, to locate a point by eye within about $\pm$ 0.002 in. with a good quality steel rule. We needn't question how accurately rules are graduated. For model-making it can be assumed that if it is undamaged, it is a truly accurate scale. It also follows from this that if you have a square with a graduated blade or clamp a rule upright against it, or to an angle-plate, and a scribing block with a fine point you should be able to set that point and scribe a line at a known height above its base within about $\pm$ 0.002 in. or 0.003 in.

Now a few words about rules. Some are more suited to the model maker's use than others. I once met a learner whose only rule was the blade of a 12 in. combination square, and it hadn't occurred to him that here was a chief reason for his failures. It was nearly 3/32 in.



thick and I couldn't have read within 1/32 in. with it. Use the thinnest rule you can get. A half-inch wide Rabone or Chesterman semi-flexible blade rule is probably as good as any available, not because it is flexible, but because it is only 0.012 in. to 0.015 in. thick. The machine draughtsman is about the only professional worker today who uses graduated scales to transfer dimensions in the way we modellers do, and you will find his scales are graduated on a finely bevelled edge to reduce sighting errors to a minimum, but however useful otherwise, a draughtsman's steel scale is too large and clumsy for most small work. Years ago when rules were more important to engineers than they are now, there used to be bevel edge toolmaker's rules on the market, but they are not made nowadays as far as I know. I still have a lovely little 3 in. rule of this type made about 50 years ago, and anyone lucky enough to get hold of one should treasure it (see Sketch *P*).

Apart from this, use thin rules 0.020 in. thick or less; 4 in. or 6 in. lengths are more useful than 12 in. and it is useful to have still shorter ones. Some years ago I cut up a 6 in. rule to make $\frac{3}{4}$ in., 1 in., $1\frac{1}{2}$ in. and 2 in. pieces with a little holder to handle them easily with. They greatly assist marking off small parts.

**Other Tools**

Besides the rule, the model maker's principal instruments will be, square scribers, centre punches, dividers, scribing block, jenny calipers and a pin hammer. Remember that if you are to do precision work these are all precision tools—even or especially the hammer—to be treated with care and respect and kept in first-class condition—and of a suitable size and type for small work. For instance, how many model makers, I wonder, have tried (and failed) to use a 6-in. square on a component part of a model whose dimensions may be say about $\frac{1}{2}$ in. $\times \frac{3}{8}$ in.? The smallest squares to be bought are about $1\frac{1}{2}$ in. blade, and even they are too large and clumsy for much tiny work. It is not difficult, and a good exercise in accurate work, to make a tiny square for your own use. The inside square is the most useful, and it has to be provided with a handle to be held in a pin-vice. Sketch *T* gives details and dimensions of the one I use myself, and I couldn't get far without it.

The points of centre punches, scribers, dividers and jennies must be kept quite sharp. The test for your centre punch and incidentally your own delicacy of touch is to be able to feel it drop into a previously scribed line. Then draw it along that line carefully until it meets the scribed cross-line, where you want your hole centre to be. You should be able to feel it drop into the intersection. If your hearing is good enough, you might even hear the faint click. If you can neither feel it nor hear it you will need to improve your tools or touch, or both until you can, or give up the idea of doing accurate small work. Tests for your scribers, divider points, etc., are to be able to feel them drop into the fine graduation lines on your rule.

The usual bought centre punch has a point angle of about 90 deg.; don't use anything broader for model work—though I've seen them all angles from about 80 deg. to 120 deg., and I suppose the average model maker, if he thinks about his punch at all, envisages its point, and the indentation it makes in terms of Sketch *A*: (Note.—Sketches *A* to *K* are shown much exaggerated in size as I am only dealing with small work.) Actually the state of affairs is much more like *B*, which shows in fact a good accurate placing and a square strike, and might result in a correctly drilled hole, but if you look at the drill (at *F*) there is still some element of chance about it. At *C* the operator has struck his punch "off square" with the quite unexpected result: that it tends to get deflected in the opposite direction to what you would expect and the softer the material being used the more pronounced is this effect. The burr builds up higher against the steeper slope of the punch and tends to force it in the direction of the easier one. This is why three things are vitally important for accurate use of the centre punch.

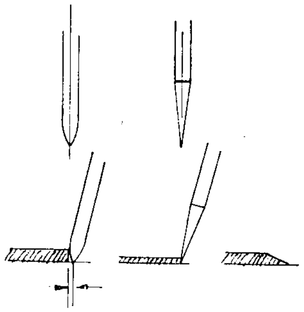
1. To keep the point sharp and truly conical.
2. To find the correct centre before striking.
3. To keep the punch upright for the strike.

In addition to these chances of error, sometimes, who knows, the user's punch may be more like *D* with a nasty little bit flaked off the point. It has happened to me so I know it can to others, and the resulting indentation might be any old shape, with just a matter of good or bad luck where the drill wanders to.

At *E* is shown the case where the worker has made a bad shot, definitely off the centre line while *F* shows what happens if he makes the not unnatural, but perfectly fatal mistake of trying to correct his error by tipping his punch over 40-45 deg. and striking towards the desired position. It only makes a bad error worse. True he may drive the punch by main force nearer the scribed line and seem correct to the eye, but a high burr has been raised on one side and a depression created on the other, both precisely where they will do most harm in deflecting the drill point still farther away from the correct position. The only thing to do in a case like *E*, is to smooth off the burr with a fine file and try to reset with a spotting punch or spear drill.

**Using the Centre Punch**

In point of fact, a centre punch like that shown in sketches *A* to *F* should never be used for first spotting for tiny holes in small and accurate work. Use it afterwards if you like to deepen and widen a positively located spot, but only with the greatest care. The type required is a spotting punch shown in sketches *G* and *H* and it may have to be made by the user for himself, since as far as I know, nothing of the sort can be bought small enough for fine model work. Possibly Moore & Wrights may have something like it in their range. If so get one, as it is likely to be a better tool than a home-made one. This is the type of punch to feel along scribed lines with. Keep the point always stoned up sharp and NEVER strike it with anything heavier than a 2 oz. pin-hammer. The kind of indentation you ought to get is shown at *H* and while you can enlarge this with a heavier 90 deg. punch it is safer and better for accuracy to do it with a sharp watchmaker's spear point drill held in a little archimedian turn, and with this tool you can quite easily set punch marks over a little if out of position.



N O P

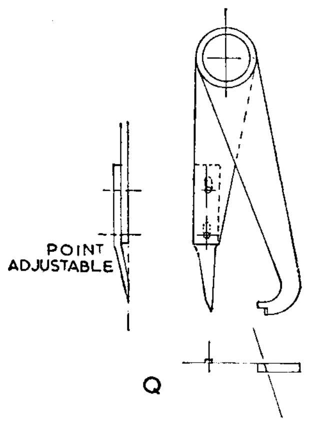
By the way I should have included in the list of marking off equipment earlier, some means of holding small parts secure and steady, flat and square while marking off, punching, and of course drilling. It is quite essential that the seeker after accuracy should provide himself with a finger-plate of the kind I described in THE MODEL ENGINEER for February 22nd, 1951 or some similar appliance. It is one of the most important tools in my workshop, as good as a third hand and in almost constant use.

Sketches *L* and *M* show suggestions for further practice and test of ability. Take a little piece of metal, brass for preference, flat and with at least one straight edge. Scribe a line down its length with the jenny (Fig. *Q*), of which more anon. Take your dividers and set them as carefully as you can to some standard dimension (say ¼ in.). If the points are sharp you should be able to slide them in the two selected graduations with no tendency to slip out. From a selected point on the scribed line walk your dividers down it for six steps, mark the sixth, and measure from the starting point. If you are within ± 1/64 in. of 1½ in. that is quite accurate enough. If not try again, practice will quickly help you especially to swing the dividers round on a point each step without slip. When you find that you can achieve this fairly readily, it means that you can rely on yourself to mark off with dividers within average limits of about ± 0.002 in. to ± 0.003 in. and that is good enough for all model-making, however much it might be sniffed at in a modern tool-room.

**Warning**

I must add two warnings on the use of dividers. First, don't use a large pair (4 in. to 6 in.) on small work. Their legs are too springy and you need to reduce this to a minimum. It is a good plan to cut a 3 in. or 4 in. pair well short, down to 1½ or 2 in., keeping the broader stiffer upper parts of the legs of the full section down as far as possible and taper them off fairly quickly to the new points. Many model engineers have no doubt discovered, on trying to set one up true in the lathe, that it is almost impossible to scribe a true circle with the average spring dividers as sold due to leg spring. It can be done by holding the dividers still and turning the piece of work, but it isn't always possible to do this.

Secondly, don't use the method (suggested as a test only) given above of walking dividers down a line for marking off a row of hole positions, except perhaps in the very special case of marking round an oval, or irregular shape, where you can begin and end at the same point. It makes the small error nearly always present a cumulative one. Marking off around a circular pitch line can be done much more accurately by the mechanical methods to be described later.




Q

Now take the piece of plate and mark off cross lines with a square as shown, and spot-punch lightly at each intersection, sliding or drawing the punch down the longitudinal till you feel it drop into the crossing point. That is the point to spot. Then with a small dead smooth file remove all the burrs without obliterating the scribed lines and examine the result with an eye-glass. Always use an eye-glass for scribing and spot-punching unless your eyesight is exceptionally good. A first attempt may look like *M* or worse. Scribe another longitudinal and try again, and again if necessary.

Sketches *N* and *O* illustrate bad and good scriber points and they apply equally to scribing block, dividers and jenny. *N* also shows the combination of a bad scriber with a thick rule (or square blade—most squares as sold, have blades too thick for model work, and need extra care when scribing). The error introduced here could easily be 1/32 in. When new, a scriber may have a nicely conical point, as *O*, but when blunted don't try to sharpen it on a grinder. You will only soften it. Sharpen by stoning three or four flats with a carborundum slip and/or oilstone and though the shape gradually changes to taper square or triangular it will function just as well.

**Inaccurate Tools ?**

Jenny calipers have been stigmatised by some people as useless and inherently inaccurate tools, but don't believe them. It is true, however, that the average commercial product looks as if it had been designed by someone who never had to use it. It can be a most useful adjunct capable of as accurate work as any of the rest of your marking off equipment, but to fit it for small work the commercial article has to be modified. Fig. *Q* shows the alterations.

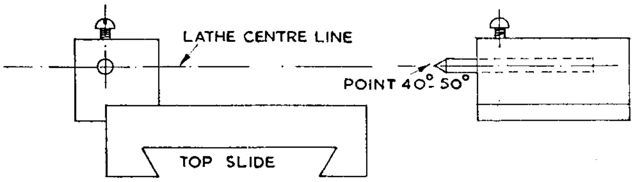
1. File away part of the dog leg to provide a horizontal lip to rest on the edge of the work and bevel off the back end as shown. Note—make the lip as long as you can, longer than shown in the sketch if there's enough metal in the dog leg, the longer the better to support the scriber at close settings.

2. Cut the scribing leg short and fit a new adjustable point and give it a set so that the scribing point, which should be flattened, bears close against and can be supported by the edge of the lip. Sharpen only on the outer faces.

To do accurate work the high point of the bevel at the back of the lip and the scriber point must be closely in line. Always hold the tool square to the edge of the work, and draw it slowly along tilted slightly forward. When scribing a line very close to an edge, and it is quite possible to scribe down to 1/64 in. if ever necessary, very exact adjustment of the depth of the point in relation to the supporting lip is necessary.

**Drills**

The best of marking off can easily

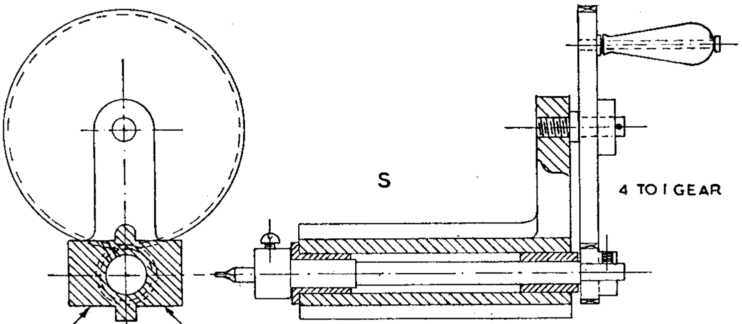



R

be ruined by faulty drills. You need to be much more particular about keeping small drills ($\frac{1}{16}$ in. and below) sharp than larger ones. Forcing a tiny drill when blunt means almost certain breakage. There is absolutely no need for elaborate twist drill grinders for these small sizes or indeed for any twist drill below about $\frac{1}{8}$ in. diameter. It is much to be doubted whether any of the types likely to be owned by an amateur could be relied on to sharpen any drills between 0.030 in. and 0.060 in. diameter so well as can be done by hand with a slip after a little practice ; and even if it could, I would back myself to sharpen a dozen of varying sizes by hand while the grinder was being set up for one. Neither is there any necessity for curvature behind the cutting lip. A straight flat back off is quite satisfactory though I admit that I myself, more often than not, give a double set. The angle of the lips is also unimportant within 10 or 15 deg. either way, so long as both are approximately the same and meet across the centre of the flutes. With care and practice it becomes possible to sharpen small drills by hand with great accuracy merely by eye.

I fancy that the present-day craze for power operated machines, and mostly too heavy and clumsy at that, is at the root of a lot of the difficulties some model makers experience in doing fine work. If you must have a drill capable of $\frac{3}{8}$ in. or $\frac{1}{2}$ in holes then don't expect it to be suitable for drills down to 0.030 in. or 0.040 in. These drills have to be felt in operation. In one case I remember the vibration of the machine at top speed was enough to make any attempt at small critical drilling hopeless. I've never found high speeds necessary. I bought and tried a high speed, so-called precision drill some years ago, but very soon gave it up. It broke my drills and I have scores of them from 20 thou. up to 3/32 in. that have been in regular use for 30 years and more. I doubt if the highest speed I can reach with my little treadle drilling machine is over 400 r.p.m., and I seldom go all out. A lot of my smallest drilling (16-B.A. tapping or about 0.024 in.) is actually done with a hand drill at say 200 r.p.m. or less ; but this is a specially small and precision type of my own make.

Tiny twist drills are over long in the flutes and very fragile. The cost of them today is such that it is worth an effort to save them. I encase all those from 0.020 in. to 0.039 in. diameter that I use frequently in watch maker's bouchon wire. This is thick-walled brass tube sold in $2\frac{1}{2}$ in. lengths, in a large variety of diameters from $1\frac{1}{2}$ to 5 mm., and with bores rising from $\frac{1}{2}$ to 2 mm. by 10ths of a millimetre, I believe, and though I don't think any suppliers of watch repairers' sundries stock the whole range (they are of Swiss manufacture) it is seldom that I have found any difficulty in getting any size bore within reason that I need. Put your small drills in suitably sized pieces of bouchon wire. They should be a good fit (say within 0.001 in. or 0.002 in.) and project at the drilling end for $\frac{1}{8}$ in. to $\frac{3}{16}$ in. and a spot of soft solder at the tail end is enough to hold them. If by bad luck you break a tip you can shorten the bouchon, and expose a new length of drill just as if it was pencil.



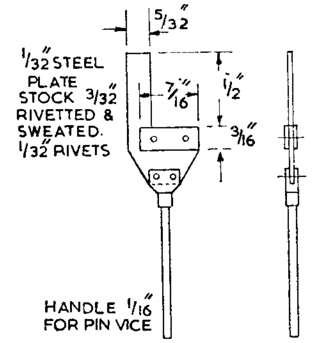

These bouchon wires average about 6d. each at the present time, and are made dead straight ; bores central and to high dimensional accuracy. One bouchon wire will case three small drills. Of course it is quite possible to drill out 3/32 in. or $\frac{1}{8}$ in. brass rod for this purpose, but to drill a 20-thou. hole say through a $\frac{3}{4}$ in. length of it and straight, would be a tax on any model maker's equipment and skill.

### Machine Aids to Marking-off

While it is most important to cultivate accuracy in your hand methods, there are certain kinds of marking off which can be done better and much more accurately and quickly in the lathe with quite easy improvisation, provided that it has a division plate. If it has not the owner would be well advised to fit one. You don't need a great many rows of holes ; 60 and 72 should cover all normal needs and it is an essential fitment for small and accurate work, though I say candidly that the very idea of putting one on a power operated lathe would scare me. Take the greatest care to ensure that the detent arm has a positive spring out-of-engagement lock. This arm needs careful making and fitting. It must be rigid enough to hold the lathe spindle quite stationary, and springy enough to enable the detent pin to enter and leave holes easily. The arm also needs to be adjustable for length at least as much as the longest distance between two adjacent holes on the division plate. This is to enable a job held in the chuck, to be squared up when marking off has to start at a predetermined point which does not exactly fall on the lathe centre line when the detent pin is in the nearest hole. Marking off in the lathe takes advantage of the fact that even with a cheap type of machine the pitch and micro-index of the cross-slide screw ought to give you greater linear accuracy than you can attain by hand methods and the division plate should be far more accurate than dividers for marking off for holes on a pitch circle.

### A Marking-off Gadget

The simplest little gadget possible for machine marking-off is shown in Sketch *R*. A little block of steel, cast-iron or brass should be made to bed down on the top-slide with an edge register in contact as shown. It woud be held in position like a slide-rest tool. In this position and at a carefully recorded setting of the cross-slide index, drill a hole to hold a $\frac{1}{8}$ in. diameter scriber which must fit the hole without shake and have a truly central point and a minimum of projection in use. The recorded setting is your reference zero point for all subsequent use of the tool, and as all your marking off will be done by measurement from the centre outwards, take care to drill the hole with the setting on an outward pull so that you don't have to correct for backlash every time you use it. Feed the scriber against the work with the top-slide




T

using contact + 0.002 in. for steel work, + 0.003 in. for brass and gun-metal. Cast-iron may need from 0.003 in. to 0.004 in. depending on its quality (and on your quality of surface machining). With this tool you can scribe pitch circles to a known radius with the accuracy of the cross-slide screw, by traversing it outwards from your zero point and reading the micro-index, and then using the division plate to scribe short cross-lines. This gives you the spotting points for subsequent centre punching. For instance you might mark off the holes on a cylinder flange after turning and boring it, and before you remove it from the chuck, and if you record the slide-rest setting on the drawing, say, you can mark off the covers similarly long after by merely repeating the setting in the certainly that the holes will mate. You wilt find it capable also, of various kinds of straight line marking off to the limits of accuracy of your cross traverse screw.

**Spotting for Drilling**

A still more useful fitment for the same purpose is shown in Sketch *S*. The scriber is here replaced by a hand operated spindle, carrying a $\frac{1}{8}$ in. diameter centre drill and instead of just marking off for centre punching, you can spot the holes all ready for drilling. It is quite a simple little tool to make. The body could be built up of steel, cast-iron might be better and only a simple pattern would be required. Dimensions depend entirely on the lathe it is to fit. Don't make the spindle too heavy, $\frac{5}{16}$ in. in the front bearing and $\frac{1}{4}$ in. in the rear are ample. Keep the front overhang as short as possible, and don't try to do any more than spotting holes. Remember you have only got a tiny detent pin in a small hole to keep the job steady so don't try to improve matters by fitting a drill chuck on the spindle nose to do direct drilling with the tool in place. The combination of overhang and wobble thereby introduced will wipe out all chance of the accuracy hoped for.

A 4 to 1 geared drive will be quite enough. Unless you are equipped to cut your own wheels, a pair of standard 100-25 × 40 d.p. gears as stocked by Messrs. Bond or other MODEL ENGINEER advertisers should be quite suitable.

You will notice that two setting registers (*X* and *Y*) are shown on sketch *S*. *Y* is the one normally used and that at which the tool should be bored. *X* is not strictly essential, but if included it will increase the versatility of the appliance, as it could then be set at right-angles on the front edge of the tool-slide to do cross spotting on the centre-line or used for occasional outsize work by setting it up on the outer edge.

You can make this spotting tool of vastly greater all-round capacity at the cost of rather more complication if your lathe is equipped with a vertical-slide. Bore out the fitment, which may require a rather differently shaped body piece, mounted on the latter instead of on the tool-slide at recorded settings of both cross- and vertical-slides at inward and upward pulls respectively if all your operations will be in the right upper quadrant of the circle represented by the lathe faceplate, as in this case they may have to be. It depends on the type of lathe and vertical-slide. You will get the other three quadrants by means of the division plate. This fix up will enable you to spot holes with pretty close accuracy by offsets from zero point (the lathe centre), anywhere within the lathe swing on either radial, circular or rectangular pitch lines to any desired measurement by careful combined use of vertical and horizontal actuating screws and division plate. You will have in effect a sort of elementary jig borer.

# TWIN SISTERS

(*Continued from page* 452)

is trying to find fault with the full-size system ? If by chance a *different* form of braking came into being, it is not inconceivable that a *different* form of linkage might be required to go with it—so wait and see !

**Drawings**

My house is open to all locomotive enthusiasts from every part and every country, and those who have visited me since my illness have had the pleasure (?) of seeing me work in my workshop and on my drawing board.

In case you are interested, I can stand up, drive my car, walk about 50 yards without resting, stand (or sit) at my lathe or milling machine but *I cannot bend over the old-fashioned drawing board.* In order that I may continue to make locomotives, drawings, patterns, lots of bits and pieces for other good folk, and last but not least, continue to write for this journal, my system of working has had to be altered to suit *me*. I now have a drafting machine at which I can sit in comparative ease—just like sitting down to lunch ; whilst in my workshop, following the same fanatical course I have always followed, I continue to make *every single part myself*—even to the "absurdity" (as some say) of turning out hundreds of stainless-steel bolts and nuts. I am no dab hand at painting, but have now built up equipment so that, perfect or imperfect, every bit of painting, lining, lettering is done by me in my own garden workshop. I cannot imagine the sort of person who could possibly gain any pleasure from letting other people or firms make the parts for him. I may be handicapped to some extent, but if ever I am unable to make *all my models entirely myself*, that will be the time to stop.

But here we have a definite complaint from "L.B.S.C." to the effect that I should have published the "geometry" of the valve motion for "Twin Sisters." We all have our own ways of working and I am no exception to the rule. The information that has been published by me, has been generous enough for builders to carry out the instructions without any hitch at all. I am equally sure that, had the information been skimped in any way, I would have been the first to hear about it.

If any man thinks he can lay claim to having made any part of my own "Twin Sister," he should, with my consent, publish his name and address ; he is just the man I want to meet.

(*To be continued*)

# QUERIES AND REPLIES

"THE M.E." FREE ADVICE SERVICE. Queries from readers on matters connected with model engineering are replied to by post as promptly as possible. If considered of general interest the query and reply may also be published on this page. The following rules must, however, be complied with:

(1) Queries must be of a practical nature on subjects within the scope of this journal.
(2) Only queries which admit of a reasonably brief reply can be dealt with.
(3) Queries should not be sent under the same cover as any other communication.
(4) Queries involving the buying, selling, or valuation of models or equipment, or hypothetical queries such as examination questions, cannot be answered.
(5) A stamped addressed envelope must accompany each query.
(6) Envelopes must be marked "Query" and be addressed to THE MODEL ENGINEER, 19-20, Noel Street, London, W.1.

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### Electric Clocks

*I am proposing to make a Hipp "Butterfly" clock. I would like to use a "seconds" pendulum. Could you please tell me:*

*(a) The overall length of the pendulum.*

*(b) The diameter of the pendulum rod.*

*(c) The dimensions for a mild steel bob.*

*(d) Details for the electric magnet.*

*(e) An address where "Invar" may be obtained.*

R.I.H. (Oundle).

(*a*) The *effective* length of a pendulum rod to have a period of one second for each single swing, is 1 metre (39.38 in.) from the point of suspension to the centre of gravity. In practice the rod must be longer than this, as the weight is mainly centred in the pendulum bob, and the actual length will vary slightly according to the proportions of the bob. Usually this works out to approximately 41 in.

(*b*) The diameter of the pendulum rod may be varied within a fairly wide range, but a suitable diameter for a steel rod would be $\frac{5}{16}$ in.

(*c*) The weight of the pendulum bob should not be less than 14 lb., and if made cylindrical, in iron or mild steel, it may be $7\frac{1}{2}$ in. long by $2\frac{1}{2}$ in. diameter.

(*d*) The details of the electro-magnet may vary according to the design of the clock, but assuming that the usual form of magnet, consisting of two cylindrical cores connected to a rectangular yoke, is used, the cores may be about $\frac{5}{16}$ in. diameter by 2 in. long, and each wound with approximately 900 to 1,000 turns of 26-gauge enamelled copper wire. These windings are connected in series, to produce opposite polarity to the open ends of the core.

(*e*) Invar pendulum rods may be obtained from the Synchronome Co. Ltd., Abbey Works, Mount Pleasant, Alperton, Middlesex, or from The Mond Nickel Co. Ltd., Sunderland House, Curzon Street, London, W.1.

Our handbook *Electric Clocks and How to Make Them* contains full details and drawings of several types of electric clocks, including clocks of the Hipp type. This book can be obtained from our publishing department, price 10s. 6d.

### Burner for Locomotive

*Could I use a paraffin blowlamp to generate steam for my locomotive? If so, would you please inform me which would be the best type to use.*

S.M. (Hull).

A paraffin blowlamp would be quite suitable, but you will have to protect the sides of the outer shell from the effects of the extra heat. You do not give details of your locomotive, so it is impossible for us to specify a size for the blowlamp. However, we would recommend a Primus silent burner or, alternatively, a petrol burner, which works on the same general principle, the difference being that, in the latter a smaller vaporising coil can be used as the lighter fuel vaporises at a lower temperature; also it is cleaner in use, and less carbon is formed in the vaporising tubes.

### Constructing an Electric Welder

*I wish to fit up an electric welder to work from the mains (230 volts a.c.) and would like to know if it is possible to use a mains transformer from a Davenset Battery Charger, type G.C. This charger has three outputs, 15, 20 and 25 volts, to charge up to 6 amps, and 2 barreters. I would also appreciate any information about the equipment required to weld material up to $\frac{1}{4}$ in. thickness, also any books on the subject.*

B.P. (Stockport).

The equipment you have is unsuitable for any kind of welding. A voltage of not less than 80-100 is necessary; in addition, the welding transformer is a special piece of apparatus and differs in its performance from an ordinary transformer. To be able to weld up to $\frac{1}{4}$ in. thickness, currents up to 100-180 amps may be necessary. A so-called form of welding, using low voltages and a carbon rod as the electrode, could be used for producing an appreciable amount of heat, but this would not be welding in the accepted sense.

### Fuel for Petrol Engines

*I have a 10 c.c. engine intended for spark ignition, and should be glad if you would advise me what fuel mixture would be suitable for this engine.*

J.E.H. (Falmouth).

There is a very considerable latitude in the kinds of fuel that can be used with spark ignition, much more so than with glow plug or compression-ignition engines. Any of the recommended fuels for small petrol engines can be used for spark ignition, a suitable mixture for normal running being ordinary petrol 80 per cent., lubricating oil, such as Castrol XL or Essolube of similar grade, 20 per cent. For specially tuned engines of high compression, alcohol blended or other specially compounded fuels may be used, but there is no particular advantage in using fuel containing ether when spark ignition is employed.

### Steel for Machine Parts

*I intend to make some sewing machine components for experimental purposes. These are similar to a shuttle and have to revolve in a race. Can you advise me what type of steel to use, and also give the names and addresses of anyone likely to be able to supply me with the necessary small quantities: one piece 6 in. × $1\frac{3}{4}$ in. diameter; one piece 4 in. × $2\frac{1}{4}$ in. diameter.*

K.H. (Leeds).

It would appear to us that the parts you propose to make would be quite satisfactory in mild-steel, though a great deal will depend on the loading or wear which they encounter in use, and it might be found desirable to case-harden them after machining.

In view of the present difficulty in the supply of raw materials, it is probable that any special steels will be difficult to obtain in the sizes you require, besides being more difficult to machine. You may be able to obtain mild-steel of the size specified from one of the following firms: W. H. Haselgrove, 1, Queensway, Petts Wood, Kent; Kennion Bros., 9, Greenways, Hertford.